

United States Department of Agriculture  
Agricultural Research Administration  
Bureau of Entomology and Plant Quarantine

A REVIEW OF THE INSECTICIDAL USES  
OF THE ROTENONE-BEARING PLANTS, 1938-1944

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This is a continuation of the series of papers begun by R. C. Roark, which reviewed all the available information on the insecticidal uses of rotenone and the rotenoids up to 1938. Twelve parts of his review have been published in E-579; E-581; E-593; E-594; E-598; E-603; E-625; E-630; E-652; E-654; E-655; and E-656. The present paper reviews the publications dated 1938 through 1943, and several dated 1944. Species belonging to Derris, Lonchocarpus, Tephrosia, Mundulea, Millettia, Pachyrhizus, and Calopogonium are discussed. The continued interest in these plants as sources of insecticides is shown by the publication, during the last 6 years, of more than 800 articles describing tests upon insects with preparations containing rotenone or its congeners.

Information on the cultivation and marketing of derris, cube, and timbo has been assembled by the writer and will be published separately. Of the authors cited in this compilation Fallon (175) gives the most information on the economic aspects of the rotenone plants.

#### LEPIDOPTERA

##### Aegeriidae

Melittia cucurbitae (Harr.) (= satyriniformis (Hbn.)), the squash borer.

In Connecticut the 1940 tests indicated that a 1-percent rotenone dust was equal, if not superior, to lead arsenate and fish oil. In 1941 the 1-percent rotenone-treated plots had a significantly lower infestation than plots treated with a proprietary dust (walnut-shell flour impregnated with rotenone) but were not significantly lower than plots treated with lead arsenate. A year later a 1-percent rotenone dust gave effective control, particularly on early plantings when the borer population was high. The use of a pyrophyllite diluent instead of the one used (Bancroft clay) might increase its effectiveness still more.--Beard (40, 41).

In Massachusetts sprays were consistently superior to dusts in 1938. The percentage reduction of injury to squash vines was 88.5 for a spray of 1 percent of summer oil with 0.5 percent of nicotine sulfate, 81.5 for a wettable cube spray (4 lb. in 100 gal. of water), and 77.8 for a cube-clay dust (0.6 percent of rotenone).--Bourne and Whitcomb (73).



Applied four times in 1940, nicotine sulfate (1:250), nicotine sulfate (1:500) with 1 percent of summer-oil emulsion, and wettable derris spray (4 lb. per 100 gal.) with a resin adhesive reduced the infestation by 74, 77, and 35 percent, respectively. Applied four times in 1941, dusts of rotenone and talc and sprays of nicotine sulfate reduced the number of larvae by at least 79 percent. The most effective treatments in 1942 were a dust containing 0.75 percent of rotenone and "copper oxychloride sulfate", and sprays of nicotine sulfate (1:250) and of white-oil emulsion containing nicotine sulfate (1:500). Dusts containing 0.75 percent of rotenone in talc or 20 percent of cryolite with 5 percent of metallic copper were moderately effective. In 1943 a dust containing 0.75 percent of rotenone and "copper oxychloride sulfate" was effective.--Whitcomb (676, p.57; 677, p. 62; 678, 681, p. 35).

In tests conducted from 1937 to 1941 in New York, satisfactory commercial control was given by a 1-percent rotenone dust, and by a spray of 2 quarts of nicotine sulfate or 4 lb. of powdered derris (5 percent of rotenone) in 100 gal. of water. When the proportion of derris was reduced to 1 or 0.5 pound, there were marked reductions in control. Commercial rotenone extracts in sprays were of little value.--Hervey (279).

Of the rotenone sprays, only those containing 4 lb. of derris powder in 100 gal. of water gave commercial control. Sprays containing nicotine sulfate (1:400) were about as effective as the best rotenone sprays. Dusts containing 1 percent of rotenone also gave very good control.--Parrott (457).

Dust mixtures containing derris or cube were recommended for the control of this insect in 1941.--United States Bureau of Entomology and Plant Quarantine (621).

#### Arctiidae

(Apantesis) Callorctia phyllira (Drury)

All rotenone insecticides tried in Alabama were ineffective.--Arant (22, 26).

Diacrisia purpurata (L.)

A cube dust containing 6 percent of rotenone appeared to be ineffective against this pest on lavender in Basses-Alpes, France.--Pussard (478).

Estigmene acrea (Drury), the salt-marsh caterpillar

If this insect becomes numerous in Arizona before fruit harvest, derris is recommended.--Wehrle (668).

Bombycidae

Bombyx mori (L.), the silkworm

Chemical proof was obtained that dinitro-o-cresol, nicotine, rotenone, arsenic trioxide, potassium arsenate, and arsenic pentoxide pass unchanged through the cuticula from the dorsum of the silkworm. Stain reactions demonstrated the presence of permeable areas in the cuticula, including that of a living silkworm. They occurred chiefly in the membranes of the pores of the setae but were also distributed over the whole skin. It is highly probable that permeability is a purely mechanical process.--Brødenkamp (86).

In the laboratory pulverized seeds of Millettia pachycarpa were fed to silkworms. It was estimated that the seeds were about one-ninth as toxic as rotenone, and about three times as toxic as lead arsenate.--Chiu and coworkers (114).

Insects have been subjected to rotenone toxicity determinations more extensively than any other group of animals. The fourth-instar silkworm larva appears to be the most susceptible animal tested, as far as oral toxicity of rotenone is concerned. The median lethal dose is 0.003 mg. per gram. The silkworm appears to be nearly 20 times as susceptible as the guinea pig, the mammal most easily affected by rotenone. There is no evidence of any definite correlation between the position of an animal in classification and its susceptibility to rotenone. The comparative toxicities by oral administration appear to be similar for derris and cube samples.--Cutkomp (132).

Seeds of the yam bean, Pachyrhizus erosus Urban, [contains 0.1 percent of rotenone and 25 percent of fatty oil] used as a dust killed 100 percent of silkworms, and various extracts of this dust killed 100 percent or slightly less. An alcoholic extract of the roots of Millettia pachycarpa killed only 32 percent, the stems used as a dust killed 48 percent, while the seeds used as a dust killed 100 percent. An alcoholic extract of cube (4 percent of rotenone) killed only 56 percent of the silkworms tested.--Hansberry and Lee (258); Lee and Hansberry (360).

The 4,6-dinitro-o-alkylphenols and cycloalkylphenols were more toxic to silkworms than acid lead arsenate, but less toxic than rotenone.--Kagy (333).

Coleophoridae

Coleophora malivorella Riley, the pistol casebearer

In Pennsylvania two early applications of cube powder in usual spray mixture killed more than 95 percent of the larvae. It was recommended that a spray containing liquid lime-sulfur for disease control, 3 pounds of cube powder (5 percent of rotenone), and 3 gallons of lubricating oil, emulsified with  $\frac{1}{2}$  pound of sulfite lye per 100 gallons of spray be applied at the delayed dormant stage, followed at the pink stage by one of 6 pounds of wettable sulfur, 3 pounds of cube and  $\frac{1}{2}$  ounce of Antifoam per 100 gallons.--Steiner and Worthley (567).

Cube powder (5 percent of rotenone) used at the rate of 3 pounds per 100 gallons gave good results in the delayed dormant spray.--Steiner (565).

In Maryland control can be obtained during the preblossom period with one application of 4 pounds of derris powder and 8 pounds of wettable sulfur to 100 gallons of water.--McConnell (375).

Cosmopterygidae

Batrachedra perobtusa Meyr.

Larvae of this pest in Brazil feed on pollen of the coconut palm. As arsenicals scorch the palm flowers, it is preferable to use sprays of nicotine or rotenone.--Bondar (64).

Crambidae

Crambus bonifatellus (Hulst), a sod webworm

Crambus topiarius Zell. (= hortvellus Hbn.), the cranberry girdler

Crambus sperryellus Klots, another sod webworm

Temporary control of the first and third species, which damage lawns in California, was obtained by the use of sprays containing derris extract, but as the treatments did not prevent reinfestation after 3 or 4 weeks, it was necessary to repeat them one to three times during the summer.--Bohart (62).

In Massachusetts nearly all the adults of the cranberry girdler were killed with derris dust (4 percent of rotenone), applied at 50 pounds per acre, but it was less effective than pyrethrum.--Franklin (196).

Diatraea saccharalis (F.), the sugarcane borer

Cryolite killed 90 percent or more of the first generation in Louisiana. Other dusts tried included derris.--Ingram and Dugas (309).

#### Gelechiidae

Gnorimoschema operculella (Zell.), the potato tuber moth

After potatoes are harvested in New South Wales, the tubers should be stored in moth-proof containers or buildings and, if they become infested, they should be dusted with a mixture of derris and kaolin (1:4) or fumigated with carbon bisulfide.--New South Wales Department of Agriculture (444).

In preliminary tests in eastern Australia, in which potatoes were exposed to larvae for a few days, derris afforded complete protection.--Helson (276).

Derris mixture (1 percent of rotenone) at the rate of 6 ounces per hundred weight, protected stored potatoes from reinfestation in Queensland for at least 2 months after fumigation with carbon bisulfide.--Veitch (637).

Since derris was difficult to obtain in New South Wales in 1943, it was recommended that the 25-percent derris dust, usually applied to protect seed potatoes from this moth during storage, should be replaced by one of 5 percent pyridine in kaolin, which is effective and much cheaper.--Lloyd (369).

Keiferia lycopersicella (Busck), the tomato pinworm

Derris powder containing 2 percent of rotenone and 11.8 percent of ether extractives, cube powder containing 5 percent of rotenone and 26.4 percent of total extractives, and an extract containing 2 percent of rotenone were tested in California and found inferior to cryolite, which was recommended for the control of this pest.--Elmore and Howland (164).

Pectinophora gossypiella (Saund.), the pink bollworm

In laboratory tests at Presidio, Tex. in 1933, derris dust caused 72 to 100 percent mortality of larvae that came in contact with it. Poor control was obtained in the field. In 1941 derris, after exposure to direct sunlight, did not cause significant reduction, and even after



exposure in the shade, lost some of its effectiveness.--Chapman and Lowry (111).

Phthorimaea sp.

Sprays of Coposil (copper ammonium silicate), alone and with 5 percent of rotenone concentrate, or Coposil plus commercial derris, gave significant reductions in infested tomatoes in Hawaii in 1937.--Hawaii Agricultural Experiment Station (270).

Sitotroga cerealella (Oliv.), the Angoumois grain moth

In laboratory tests rotenone and derris resin were toxic to the eggs of this insect and at all stages of development.--Potter and Tattersfield (471).

The pyrethrins at a concentration of 0.007 percent were much more toxic to the eggs than nicotine or nicotine sulfate at 0.07 percent or derris extract containing 0.001 percent of rotenone, when the eggs were in early incubation, but all these were highly effective against older eggs.--Richardson (503).

Geometridae

Alsophila pometaria (Harr.), the fall cankerworm

In laboratory tests with sprays of derris, nicotine, and pyrethrum (0.8 percent of pyrethrins), the last was the most effective, and the only one of the three that gave 100 percent mortality.--Balch (33).

In comparative tests in Connecticut with lead arsenate, cryolite, and derris-rosin residue emulsion applied to large deciduous trees, rain washed off the cryolite and derris, but the arsenate stuck for several months. A good initial kill was obtained with all three materials against the young cankerworms, but lead arsenate gave the most lasting protection.--Felt and Bromley (177).

Cheimatobia brumata (L.), the winter moth

In Germany control was accomplished by spraying the moth eggs with preparations of dinitrocresol and nicotine, and the larvae with derris and pyrethrum preparations.--Thiem (589).

Hepialidae

Oxycanus, probably cervinatus (Wlk.), subterranean grass caterpillar

Sprays of arsenicals and derris were inefficient in New Zealand.



Derris may merit further attention.--Dumbleton and Dick (150).

Hesperiidae

Urbanus proteus (L.), the bean leaf roller

In Florida rotenone is recommended against this pest on beans in home gardens, after the pods form.--Watson (657).

Hyponomeutidae

Plutella maculipennis (Curt.), the diamondback moth

Field tests near Norfolk, Va., with rotenone-nicotine dust combinations indicated that these materials could be safely combined to control both aphids and diamondback moth larvae on collards. These dusts were more effective for the control of the moth than rotenone alone.--Walker and Anderson (648, 650).

Sprays or dusts containing Derris or Lonchocarpus were recommended in England in 1942.--Walton (653).

Derris resin was toxic to the eggs in England.--Potter and Tattersfield (471).

Derrisol may be used for the control of this moth on cole crops in South Africa.--Schultz (527).

This pest on cabbages in Queensland can probably be controlled by the use of lead arsenate dust before the cabbages head, and a spray of summer oil afterwards in place of dusts or sprays of derris which, in 1942, was difficult to obtain.--Veitch (637).

Derris dust or spray can be used against the larvae which attack turnip tops in New Zealand.--Pritchard (476).

A 0.1-percent nicotine spray, applied at 4-day intervals in Malaya, gave better control on cabbage than did derris or pyrethrum sprays.--Corbett and Pagden (121).

In New South Wales cabbages should be dusted every 7 to 10 days, with equal quantities of lead arsenate and kaolin during early growth, and with derris and kaolin (1:8) when the plants are heading.--New South Wales Department of Agriculture (443).

This species is further discussed under "Cabbage Caterpillars" on pages 23 to 26.

Prays citri (Mill.)

A spray of 120 grams of derris powder and 300 grams of soap in 5 gallons of water gave promising results against this moth on citrus fruits in the Philippines. It killed both the eggs and pupae with which it came in contact.--Garcia (216).

Lasiocampidae

Dendrolimus pini (L.), a pine moth caterpillar

In tests against the larvae in Germany chemical proof was obtained that rotenone can pass through the cuticula.--Bredenkamp (86).

Malacosoma neustria (L.), the lackey moth

For a given insecticide there is no fixed relation between the quantities necessary to control larvae of insects in different instars. Even the order of classification, according to insecticidal efficiency, does not remain the same for larvae of a given species during development, as shown in a table giving the minimum lethal doses of pyrethrins and rotenone per gram of body weight for larvae of M. neustria, Nygmia phaeorrhoea, and Porthetria dispar (q.v.).--Fransen (198).

A derris dust (1 percent of rotenone) killed over 80 percent of the larvae on elms in Amsterdam.--van Poeteren (469, p. 51).

Lycaenidae

Zizera labradus Godt., the bean butterfly

The larvae feed on the flowers and pods of bean plants in New South Wales, and can be controlled by dusts of derris powder (1:8), or pyrethrum powder (1:3) in kaolin or talc; or by a spray of 2 ounces of derris powder and 2 ounces of soap in 4 gallons of water.--New South Wales Department of Agriculture (444).

Lymantriidae

Lymantria monacha (L.), the nun moth

In tests against the larvae chemical proof was obtained that rotenone can pass through the cuticula.--Bredenkamp (86).

Nygmia phaeorrhoea (Donov.), the brown-tail moth

The most economical dust in Holland would be one containing 0.7 percent of rotenone used at the rate of about 3 pounds per acre, but

for technical reasons it was necessary to use 30 pounds at 0.117 percent of rotenone content.--Fransen (198).

Porthetria dispar (L.), the gypsy moth

Unfavorable results were obtained with derris released from an autogiro on woodlands. Derris extract mixtures were applied with oil in proportions that were 9 to 12 times as concentrated, in toxic ingredients, as powdered derris root.--Potts (472, 473).

In Massachusetts dusting with derris, or mixtures of derris and pyrethrum failed to control the larger caterpillars. A spray containing 15 pounds of derris (4 percent of rotenone) and 2 pounds of soap per 100 gallons of water, applied at 400 gallons per acre, was as effective as pyrethrum dusts against maturing larvae, and was much cheaper.--Franklin (193, 195).

Stilpnotia salicis (L.), the satin moth

Full-fed larvae in Holland were very resistant to rotenone but not to pyrethrum. It would be necessary to apply 45 pounds per acre of powder containing 16 percent of rotenone.--Fransen (198).

#### Nymphalidae

Pareva vesta F. (= Acraea issoria Hbn.), the China-grass butterfly

Aqueous extracts of the seeds of Millettia pachycarpa were effective against the larvae of this insect in China.--Chiu and coworkers (114).

Vanessa cardui (L.), the painted lady

The two dinitrocycloalkylphenols tested were more toxic than acid lead arsenate to the larvae, and the two nitrated phenols were more toxic than rotenone.--Kagy (333).

The median lethal dose of rotenone is 0.03 mg. per gram of body weight.--Cutkomp (132).

#### Olethreutidae

Ancylis comptana fragariae (Walsh & Riley), the strawberry leaf roller

Dusts were more effective than sprays in Missouri. Four dusts were recommended, one being derris (5 percent of rotenone) mixed with

pyrophyllite or cheap flour at the rate of 1 part of derris to 4 parts of diluent.--Smith (555).

(Argyroploce) Badebecia urticana (Hbn.)

Derris dust, if applied promptly, was effective against this insect on strawberries in England.--Massee (398).

Carpocapsa pomonella (L.), the codling moth

In laboratory tests a dust containing 0.1 percent of pyrethrins, applied to adult moths, killed 91 percent in 6 hours, while a cube dust containing 0.96 percent of rotenone and 4.3 percent of ether extractive killed only 19 percent. When mature larvae were dusted with pyrethrum (0.2 percent of pyrethrins), 100 percent died in 24 hours, but the cube dust killed only 71 percent.--Gnadinger and coworkers (233).

In Washington the substitution of 1 pound of 4-percent rotenone-bearing material for 1 pound of lead arsenate failed to show better control than lead arsenate at 3 pounds per 100 gallons.--Webster and O'Neill (666).

A lead arsenate schedule, in which nicotine bentonite was replaced by a spray of rotenone powder and derris extract, gave excellent results on two varieties of apple, but was not effective on the third.--New Mexico Agricultural Experiment Station (438).

An orchard of several thousand trees was sprayed with a mixture of lead arsenate and D-X (a proprietary product containing rotenone and pyrethrum). The crop was from 95 to 98 percent free of codling moth larvae. On the check block, where the straight lead arsenate schedule was followed, only 50 to 75 percent of the fruit was clean.--Pratt (474).

Previous attempts to use rotenone against the codling moth were unsuccessful, but in tests begun in 1938 in New York sprays made with rotenone-bearing roots gave promising results and, with the addition of a spreader and adhesive, were more effective than sprays of nicotine or lead arsenate. Rotenone extracts were inferior to the powdered root. In 1938 cube (4 percent of rotenone), applied to apple trees at 4 pounds per 100 gallons, gave only 54 percent control. A rotenone extract gave 75 percent control, but powdered derris (5 percent of rotenone) used at 5 pounds per 100 gallons in 1 quart of summer oil gave 82.5 percent. In 1941 2.5 pounds of powdered derris



(4.8 percent of rotenone) plus 1 quart of oil gave 95.5 percent, Black Leaf 40 in oil 98.5 percent, and lead arsenate 97.4 percent control. A combination spray of derris with a small amount of lead arsenate and oil provided effective control. In 1942 both nicotine and rotenone sprays again proved highly effective when applied every week or 10 days during the period of codling moth activity. The three most effective mixtures were 3 pounds of Black Leaf 155 plus 1 quart of oil, 2.5 pounds of derris (5 percent of rotenone) plus 1 quart of oil, and 3 pounds of lead arsenate plus 3 pounds of lime per 100 gallons of spray, each with a commercial spreader.--Harman (261-264).

Derris, cube, and pyrethrum in 1942 gave promise as substitutes for arsenicals.--Parrott (457).

In Delaware tests to determine the value of substitutes for arsenicals against the second-brood codling moth included a spray containing 1.5 pounds of Black Leaf 155 and 1.5 pints of D-X (a rotenone and pyrethrum product) in 100 gallons of water. This spray gave 53.6 percent of clean fruit while a lead arsenate spray gave 55.1 percent.--Stearns (564).

Tests for substitutes for lead arsenate, conducted in Pennsylvania in 1941, included three treatments in which rotenone products replaced two-thirds of the lead arsenate. None of these treatments were so effective as lead arsenate on the two varieties of apples sprayed.--Worthley (701).

In Massachusetts a modified schedule, employing a commercial pyrethrum-rotenone combination containing lead arsenate at reduced strength, practically eliminated codling moth damage.--Bourne (72, p. 36).

In Germany two poison baits were tested, one a derris preparation at a concentration of 1 percent with 0.15 percent of soft soap and 4 percent of sugar, and the other containing 0.4 percent of lead arsenate with 4 percent of sugar. Moths confined with the poison died within 9 days in the laboratory and 11 days in the field. In an apple orchard sections of 83, 317, and 36 trees were sprayed 3 times, with the arsenical bait, the derris bait, and the normal arsenical spray directed against the larvae. The percentages of uninfested apples from the three sections were 62, 67, and 49, respectively, while only 11 percent of the apples from an unsprayed orchard were uninfested. No danger is likely to accrue to honeybees from the use of derris bait sprays.--Bramstedt (83).

(Notocelia) Epiblema uddmanniana (L.) (= Eucosma (N.)u. L.), the bramble shoot-webber

This moth damages berries in England. No control was obtained by



lead arsenate spray or by two applications of a spray of derris extract and soap. Atomized pyrethrum gave excellent results on a small scale.--Dicker (142).

Grapholitha molesta (Busck), the oriental fruit moth

In Connecticut when monthly applications of lead arsenate spray and dry lime-sulfur were followed by six applications of a spray containing derris and skim-milk powder, 80 percent of the fruits were uninjured by this pest.--Garman (218).

Grapholitha packardii Zell., the cherry fruitworm

In western Washington, infestation was reduced for the second year by sprays containing lead arsenate, calcium arsenate, derris, or phenothiazine.--Breakey and Webster (84).

Polychrosis botrana (Schiff.), a European vine moth

In Germany complete mortality of the winter pupae was obtained with suitable 2-percent oil emulsions containing 0.5 percent of rotenone.--Stellwaag (568).

Polychrosis viteana (Clem.), the grape berry moth

Since table grapes cannot be washed without severe cracking, two types of spray schedules were used in New York in 1942--(1) the "split schedule" in which calcium arsenate was used in the first two applications and plant-product insecticides, such as nicotine or rotenone, for the later treatments; and (2) the "full schedule" in which plant-product insecticides were used in all the applications.--Parrott (457).

In a schedule of sprays that would avoid excessive arsenical residues, two formulas were used--one containing calcium arsenate and the other Black Leaf 155 Concentrate (fixed nicotine). The substitution of derris (4 percent of rotenone) at the rate of 4 pounds per 100 gallons for the nicotine gave 79.1 percent control.--Taschenberg and Hartzell (581).

Rhyacionia buoliana (Schiff.), the European pine shoot moth

Two applications of a spray containing 4 pounds of derris or cube and 3 pounds of fish oil in 100 gallons of water gave good control. This spray was more effective than one containing 3 pounds of

lead arsenate and fish oil.--Connecticut Agricultural Experiment Station (120).

Rhopobota naevana (Hbn.), the black-headed fireworm

In Washington rotenone preparations were tested from 1939 to 1942. A 1-percent rotenone dust gave good control of the larvae but had little effect on the adults, whereas a pyrethrum dust (0.1 percent of pyrethrins) destroyed both stages. A proprietary spray material (Visco) containing pyrethrum and rotenone was also satisfactory. In field experiments a higher kill was obtained when the rotenone was in solution than when it was in suspension. A combination of rotenone and pyrethrum gave better control of both the fireworm and cranberry fruitworm than either material alone. Cryolite and lead arsenate, both with oil, were more effective in combination with rotenone than when used alone. None of the materials tested were so effective as a spray of pyrethrum and rotenone combined.--Crowley (127-129).

The second generation was controlled with derris dust (4 percent of rotenone) without an activator, applied at 50 pounds per acre. Dusting with pyrethrum or rotenone material was very effective against this pest on cranberry plants in Massachusetts.--Franklin (193, 194).

#### Papilionidae

Papilio ajax L., the black swallowtail

Nicotine is ineffective, whereas rotenone is effective against the larvae on vegetables.--McIndoo (383).

#### Phalaenidae

Triphaena promuba (L.) (= Agrotis T. p. L.), yellow underwing moth

The larvae on carnations in England were killed by derris powder.--Speyer (558).

Agrotis ypsilon (Rott.), the black cutworm

Derris dusts were not very effective against this species and other Agrotinae on cabbage in the field in South Carolina.--Reid and coworkers (499).

Anticarsia gemmatilis (Hbn.), the velvetbean caterpillar

Rotenone-containing insecticides were almost entirely ineffective against half-grown larvae on vegetables in Alabama.--Arant (22, 26).

Trichoplusia ni (Hbn.) (= Autographa brassicae (Riley)), the cabbage looper

Rotenone dusts were less effective than pyrethrum dusts for checking infestations on Long Island. Powders of derris, cube, and timbo having nearly equal extractive content did not significantly differ in protective values. Dust mixtures of 0.5 to 1 percent rotenone content were of nearly equal value for control purposes.--Huckett (296).

Rotenone dusts were much less efficient than lead arsenate spray. Syntone (2.8 percent of rotenone), NNOR (1 percent of rotenone), and Special Agicide Concentrate (a derris suspension) were decreasingly effective in the order named. Derris powder (4 pounds to 100 gallons) was superior to all the other treatments because it contained four times as much rotenone. The imported cabbage worm was much more susceptible to rotenone than was the cabbage looper. There was little or no difference between derris and cube; small but consistent differences in control between 1, 0.5, and 0.25 percent rotenone dusts at 20 to 25 pounds per acre; and none between dusts of 1 and 0.5 percent rotenone content when the rate was higher. In 1939, four, three, and two applications of a 0.75-percent rotenone dust increased the yield by 22.9, 16.5, and 12.6 percent, respectively. It was concluded that a 0.5-percent rotenone dust is as effective as a more concentrated one if it is applied at 35 to 40 pounds per acre, and that the best dust for use on cabbage consists of a mixture of rotenone-bearing root and a carrier such as talc.--Hervey (278, 280, 281).

A dust containing 0.6 percent of rotenone and 3 percent of Lethane 384, and also dust containing 0.4 percent of rotenone and 2 percent of Lethane gave very promising results near Norfolk, Va., as compared with the other derris dusts.--Walker and Anderson (647).

(Autographa) Anagrapha falcifera (Kby.), the celery looper

In 1942 it was recommended that a 0.75-percent rotenone dust be substituted for the 1-percent dust formerly used against celery and lettuce loopers.--United States Bureau of Entomology and Plant Quarantine (626).

Rotenone was recommended against loopers ("greenworms") on lettuce in North Carolina in 1943.--Maxwell (407).

Brotolomia metricalosa (L.), the angle-shades moth

Derris dust prevented the feeding of larvae on roses in England up to 4 days but did not kill them.--Speyer (558, p. 73).

Busseola fusca (Fuller), a maize stalkborer

Under the intensive system of farming in South Africa two of the control measures consist in top dressing of the plants with Derrisol and cutting of the infested plants.--Union of South Africa Department of Agriculture (609).

Callopietria floridensis (Guenee), the Florida fern caterpillar

An outbreak on ferns occurred in nursery greenhouses in Los Angeles. Treatment with a 2-percent Rhotonon (? rotenone) solution, 1 ounce to 4 gallons of water, and use of light traps for several months resulted in complete control.--Comstock (119).

Nicotine is ineffective, whereas, rotenone is effective against this pest on vegetables.--McIndoo (383).

Ceramica picta (Harr.), the zebra caterpillar

Rotenone dusts were not effective on Long Island.--Huckett (295).

Charaas graminis (L.), the "antler" in England

In Germany when mature larvae dusted with pyrethrum or derris preparations were transferred to untreated grass sod, 50 percent died in 9 days; but when larvae on the sods were dusted with a derris preparation or calcium cyanamide, 74 and 78 percent died.--Maerck (387).

Feltia subterranea (F.), the granulate cutworm

Derris dusts were not very effective in South Carolina.--Reid and coworkers (499).

In Alabama all rotenone insecticides tried were ineffective.--Arant (26).

Heliothis armigera (Hbn.), the bollworm, corn earworm, tomato fruitworm

On Cotton: Calcium arsenate alone gave a yield of 673 pounds of seed cotton per acre while a mixture of this arsenate and cube (80 to 20) gave only 635 pounds.--Moreland (423).

In tests made in Texas calcium-zinc arsenate gave a little better control than either calcium arsenate alone or a calcium arsenate-rotenone mixture, but the difference was not significant.--Gaines (210).



On sweet corn: The use of mineral oil plus 3 percent of dichorethyl ether appeared to be a practical method of controlling this pest on sweet corn for market in Maryland. The addition of 0.1 percent of pyrethrins to the oil <sup>did not</sup> increased its effectiveness, but the addition of derris extract or nicotine.--Ditman and coworkers (147).

The mineral-oil injection method was tried in Hawaii. Oil was applied alone, and with the addition of a derris extract (5 percent of rotenone in a total of 20 percent of extractives dissolved in camphor oil) which was used at the rate of 36 cc. per gallon of oil, giving 0.05 percent of rotenone in the mixture. 0.8 cc. of oil was ejected at a time on silks as near the tip as possible. Two weeks later the percentage of tips damaged by larvae was 10.6 when oil was used alone, 6.2 when derris extract was added, and 60.8 on untreated plants. A single treatment of the field may be sufficient.--Schmidt (522).

A dust of derris and talc (1:3) was effective in some cases in Puerto Rico.--App (20).

On Tomatoes: In Hawaii sprays of copper ammonium silicate used alone, or with a 5-percent rotenone concentrate, or with a commercial derris added, gave significant reductions in percentage of infested fruit.--Hawaii Agricultural Experiment Station (270).

Of 30 chemicals tested against third-instar larvae, derris (5 percent of rotenone) and basic copper arsenate had the most delayed effect but killed at least 90 percent.--Sherman and coworkers (537).

Cube (5 percent of rotenone), mixed with 4 percent of cottonseed oil and kaolin, and used as a dust, gave no control in South Carolina.--Watts (660).

Rotenone and copper-rotenone were called poor for this pest in victory gardens in Indiana in 1943.--Reed (496).

On Other Plants: Rotenone was of little value against this insect on lima beans in Tennessee.--Marcovitch (394).

Rotenone dusts were ineffective on snap and lima beans in Maryland.--Ditman (143); Graham and Ditman (240).

Derris dust apparently did not affect it on broccoli.--Walker and Anderson (645).

Derris dusts were ineffective on cabbage.--Reid and coworkers (499).



The corn earworm and outworms are not satisfactorily controlled by either rotenone or pyrethrum, but must be combated with arsenical and fluorine compounds.--Reid (497, p. 3).

(Mamestra) Barathra brassicae (L.), a cabbage moth

In Scotland the larvae can be controlled by dusting the plants with nicotine, pyrethrum, or derris.--Cameron (99).

Sprays or dusts containing Derris or Lonchocarpus were suggested for control in England.--Walton (653).

A derris mixture (0.75 percent of rotenone) was applied successfully in Holland against the larvae of Mamestra (probably M. brassicae) on tomatoes.--van Poeteren (470, p. 73).

Papaipema purpurifascia (G. & R.), columbine borer

Dusts of derris mixed with talc were effective if applied, during the hatching period, to cultivated aquilegia plants and soil around them.--Matthewman (404).

Plusia signata (F.)

In New Guinea the larvae on tobacco can be controlled with derris dust.--Froggatt (204).

Polia oleracea (L.), tomato moth

Young larvae on tomatoes in England were killed by the addition of derris extract (0.002 percent of rotenone) to a 1-percent petroleum emulsion, and all except some mature larvae by a spray containing 0.0045 percent of rotenone; but 0.007 percent was necessary to give a complete kill.--Read (495).

Prodenia eridania (Cram.), the southern armyworm

The ingestion of rotenone was followed by no changes in the epithelium or muscle fibres, but the ingestion of arsenicals was followed by disintegration of the midgut epithelial cells and damage to the midgut muscle fibres. Silkworms died within 2 hours after ingesting minute quantities of rotenone, whereas southern armyworms readily ingested 59 to 10 mg. in sandwiches without showing any ill effects.--Woke (699).

Feeding rotenone, nicotine, pyrethrum, and phenothiazine in sandwiches caused little or no change in the blood cells and no significant

difference in the glycogen index between the fore and hind ends of the larvae. The arsenicals caused marked changes in the blood cells.--Yeager and Minson (705).

Prodenia litura (F.), the grey-streaked moth

In New Guinea the larvae on tobacco can be controlled with derris dust.--Froggatt (204).

#### Phycitidae

Acrobasis juglandis (LeB), the pecan leaf casebearer

A pyrethrum-rotenone spray, applied in early spring when 95 percent of the larvae had become active, gave good control in Florida.--Phillips and Bratley (466, p. 72).

Ephestia kuehniella Zell., the Mediterranean flour moth

In one instance the pyrethrins were  $2.66 \pm 0.26$  times as toxic as a Derris elliptica resin (rotenone content  $\overline{37}$  to 40 percent) to the eggs.--Potter and Tattersfield (471).

Etiella zinckenella (Treit.), lima bean pod borer

Dusts and sprays containing rotenone gave inferior results, pyrethrum gave moderately effective results, and cryolite reduced the population by over 90 percent in Puerto Rico.--Scott (533).

Mineola vaccinii (Riley), the cranberry fruitworm

In field experiments in Washington a higher kill was obtained when the rotenone was in solution than in suspension. A combination of rotenone and pyrethrum gave better control than either material alone. Cryolite and lead arsenate, both with oil, were each more effective in combination with rotenone than when used alone.--Crowley (128, 129).

Good control in Massachusetts was obtained with sprays containing 8 pounds of derris or 10 pounds of cube (both 4 percent of rotenone) and 2 pounds of soap in 100 gallons of water. A 2-percent rotenone dust with an activator and wetter, applied twice at the rate of 100 pounds per acre, was highly effective. A derris dust (4 percent of rotenone) without an activator was satisfactory at 50 pounds per acre. A spray of lead arsenate gave good control on experimental plots when applied at 400 gallons per acre, though it was less effective than derris or cryolite.--Franklin (192, 193, 196).

In New Brunswick a derris spray gave significant control, but a derris dust and a spray of nicotine sulfate did not.--Maxwell (406).

### Pieridae

#### Pieris brassicae (L.), the cabbage white butterfly

In England a 0.1-percent rotenone dust gave satisfactory control of this pest on Brassica crops under field conditions. The following formula was used: Lonchocarpus nicou (4 percent of rotenone) 2.5 pounds, gypsum seconds mineral 92.5 pounds, and amorphous silica dust 5 pounds. About 70 pounds of the dust per acre were required to dust a crop in autumn.--Kearns (338).

Derris resin and rotenone were toxic to the eggs in laboratory tests.--Potter and Tattersfield (471).

Sprays or dusts containing Derris or Lonchocarpus were suggested in 1942 for control of the caterpillars on garden crops in England.--Walton (653).

Derris, in either dust or spray form, can be used in New Zealand to protect the tops of turnips.--Pritchard (476).

#### Pieris canidia (Sparrm.)

Derris sprays gave promising results against this species on cabbage in China.--Chan (110).

#### Pieris napi (L.)

Rotenone sprays and dusts were suggested in 1942 for control of this species on garden crops in England.--Walton (653).

#### Pieris rapae (L.), the imported cabbage worm

Rotenone dusts were very effective in most cases in New York. Syntone, NNOR, and Special Agiocide Concentrate were decreasingly effective in the order named. Derris (4 pounds to 100 gallons) was superior because it contained four times as much rotenone. The addition of 3 percent of Lethane 60, crude soybean oil, and sodium oleyl sulfate did not increase the toxicity of the rotenone dusts.--Hervey (278, 280, 281).

An analysis was made of derris residues on marketable heads of cabbage which had been dusted at 7-day intervals with 5 applications of

a derris-clay mixture containing 1 percent of rotenone. Statistical calculations showed that, among 11,600 heads from a single acre, one U. S. No. 1 head might be encountered that would contain 73 parts per million of derris (0.525 grain per pound).--Cassil (107).

In 1941 one recommendation for the control of the imported cabbage worm in New York was the use of 4 pounds of derris (4 percent of rotenone) to 100 gallons of water plus a suitable spreader and stick-er. Experiments showed that derris sprays of one-fourth this strength compared favorably with the derris and pyrethrum dusts which are also recommended.--Pyenson and Roth (481).

Because of difference in toxicity between the yam bean and cube (4 percent of rotenone) in tests with the imported cabbage worm and codling moth, it is probable that the toxicity of the yam bean is not primarily rotenone.--Hansberry and Lee (258).

In 1941 the safest and one of the most effective methods of control for this pest was the use of derris or cube dust mixture containing 0.75 to 1 percent of rotenone.--U. S. Bureau of Entomology and Plant Quarantine (620).

Sprays or dusts containing Derris or Lonchocarpus were suggested for control of P. rapae in England. Dusts containing 0.1 percent of rotenone were effective.--Walton (653).

This species caused no damage in market gardens in Victoria where dusts containing derris or arsenates were employed.--Anonymous (3).

In West Australia, nicotine sulfate, lead arsenate, and derris were recommended against this pest.--Jenkins (322).

An alcoholic extract of the seeds of Millettia pachycarpa was effective in China.--Chiu and coworkers (114).

### Cabbage Caterpillars

All three species of caterpillars commonly found on cabbage in the United States, namely, the cabbage looper (Trichoplusia ni), the imported cabbage worm (Pieris rapae), and the diamondback moth (Plutella maculipennis), are either inferred or named in the following abstracts:

In tests in Ohio with dusts applied to cabbage, the percentages of heads free from injury at harvest were 67 for paris green, 64 for lead arsenate, and 23 for derris.--Ohio Agricultural Experiment Station (448).



In 3-year trials in Wisconsin it was possible to control both the cabbage worm and the cabbage aphid with a mixture containing rotenone (0.75 percent) nicotine (2.5 percent), and sulfur (20 percent). Derris was superior to lead arsenate for control of the imported cabbage worm and diamondback moth, but the arsenicals were better for control of the cabbage looper.--[Allen] (15); Wisconsin Agricultural Experiment Station (695).

In Alabama Derris and Tephrosia were more effective than Lonchocarpus of the same guaranteed rotenone content against a mixed infestation of cabbage worms in the field.--Arant (26).

A survey of various commercial cabbage fields in South Carolina, in which several insecticides, including derris and cube dusts, were used, showed that there was need for more adequate control measures.--Bare (34).

A derris-nicotine dust with sulfur and hydrated lime added as diluents gave excellent control of cabbage worms, as well as fair results against the pea aphid.--Brooks and Allen (91).

In Ohio in 1938 the greatest yield of cabbage was obtained by treatment with a mixture of 1 pound of derris dust (4 percent of rotenone) and 7 pounds of talc.--Gui (246).

The more important uses of rotenone include the control of cabbage caterpillars.--Howard and coworkers (294).

Rotenone dusts in 1939 on Long Island were almost replaced on a commercial scale by pyrethrum dusts. The former were not effective against the older larvae of the cabbage looper on cruciferous crops.--Huckett (295).

In Michigan cabbage worms are controlled with arsenical sprays and dusts, and by rotenone (derris), or with pyrethrum dusts and sprays. The diamondback moth is controlled with derris or pyrethrum.--Hutson (303).

The standard recommendations in New York in 1942 for cabbage insects--cabbage aphid and the three species of cabbage caterpillars--included a 0.75 to 1-percent rotenone dust or a spray containing 4 pounds of derris or cube powder (4 to 5 percent of rotenone).--Parrott (457).

A 0.5-percent rotenone dust was recommended in North Carolina in 1943 against cabbage worms on cabbage after the head is half grown.--Maxwell (407).



Rotenone and copper-rotenone were called good for cabbage worms in victory gardens in Indiana in 1943.--Reed (496).

The only satisfactory substitute for rotenone insectioides for use on cabbage after the heads begin to form is pyrethrum.--Reid (497).

As arsenicals cannot be safely used on cabbages after the head begins to form, dusts of derris and pyrethrum were tested in South Carolina in 1939 and found effective against larvae of some of the three species, but derris was more effective against the population as a whole and could be used at greater dilutions.--Reid and Bare (498).

Of the materials tested derris dust gave the most uniform results in 1941. From field experiments it was concluded that a derris dust containing 1 percent of rotenone should be most effective against the cabbage looper and diamondback moth, and a 0.5 percent dust should be sufficient where the imported cabbage worm predominates. In 1942 investigations were conducted on the number and schedule of applications of derris-China clay dust containing 0.5 percent of rotenone to protect cabbage from damage by these three species. The following treatments resulted in a considerable increase in marketable cabbage: three applications of this dust between the time the first heads begin to form and the beginning of harvest; or three applications of paris green and lime before formation of the first heads, followed by two of derris dust during the heading period.--Reid and coworkers (499, 500).

In Louisiana in 1938 three applications of a derris dust (0.5 percent of rotenone) failed to give satisfactory protection.--Smith and Brubaker (547).

In field tests in Connecticut in 1943 against a light infestation of the imported cabbage worm and diamondback moth, and a severe infestation of the cabbage looper, 1 part of derris suitably diluted with pyrophyllite was as effective as 2.5 to 5 parts of derris diluted with clay. If the control obtained by 1 percent of rotenone and clay is accepted as the desirable standard, not more than 0.4 percent of rotenone with pyrophyllite produced the same degree of control. Not more than 0.3 percent of rotenone with pyrophyllite would be required to equal the control following use of 0.75 percent of rotenone with clay.--Turner (602).

In order to conserve rotenone, pyrethrum can be substituted for it. It is better to apply an insecticide at reduced concentration to the entire crop rather than the full concentration to only part of it.--Turner and Horsfall (606).

Either a 1-percent rotenone dust or a 0.3-percent pyrethrins dust, applied at the rate of 15 to 25 pounds per acre, was formerly recommended for the control of mixed populations of these three species of cabbage caterpillars. In order to conserve rotenone it was recommended in February 1942 (1) to use a 0.75-percent rotenone dust at the same rate, with the provision that if one application is not effective a second application be given, or (2) whenever possible to use a 0.3 percent pyrethrins mixture. Other substitutes, such as paris green, cryolite, and calcium arsenate, can be used on cabbage only prior to the heading of the plants, but for other cole crops they are not recommended at any time after thinning or transplanting.--U. S. Bureau of Entomology and Plant Quarantine (626).

Nicotine is ineffective against cabbage caterpillars. A dust containing 0.375 percent of rotenone, 1.7 percent of nicotine, and 10 percent of sulfur was also ineffective.--U. S. Bureau of Entomology and Plant Quarantine (628, p. 135).

Rotenone was recommended against cabbage caterpillars in victory gardens.--Watson (657); White and Doolittle (683).

#### Pterophoridae

Platyptilia antirrhina Lange, the snapdragon plume moth

Rotenone did not give adequate control in California.--Lange (352).

Platyptilia carduidactyla (Riley), the artichoke plume moth

Cube powder, nicotine sulfate, and fixed nicotines, applied as sprays, gave limited degrees of control.--Lange (351).

Plascalea finitella (Wlk.), hill fireworm

Heavy spraying and dusting with materials containing rotenone controlled this pest on cranberry plants in Massachusetts.--Franklin (196).

#### Pyraustidae

Diaphania hyalinata (L.), the melon worm

Derris dusts containing 0.5 percent of rotenone were less effective than 1-percent dusts in Alabama. Cube appeared to be less effective than derris and timbo. A derris dust containing 25 percent of sulfur

was effective but severely burned cantaloupe foliage.--Arant (21, 26).

Nicotine is ineffective, whereas rotenone is effective.--McIndoo (383).

Rotenone was recommended for use in home and victory gardens.--Watson (657); White and Doolittle (683).

Pyrethrum is inferior to rotenone but can be used with clay or talc and sulfur to protect fall-grown squash.--U. S. Department of Agriculture (633, p. 15).

Diaphania nitidalis (Stoll), the pickleworm

In Alabama cube appeared to be less effective than derris and timbo in 1940 and 1942. Nine applications of a derris-talc-flour dust, containing 1 percent of rotenone, were effective in controlling this pest on late cantaloupes in 1941. Applications at the rate of 34.2 pounds per acre were not significantly more effective than those at 14.7 pounds per acre. A mixture of derris, talc, flour, and Cuprecide (25:64:5:6) was no more effective than the preceding mixture. On an average of 3,200 edible melons per acre were produced on 5 plots dusted with derris and talc, as compared with 96 edible melons per acre on the 5 check plots. In 1942 derris and cube dusts containing 1 percent of rotenone did not materially reduce infestation of the pickleworm until the dosage was increased to 20 pounds per acre per application. Twelve dustings at 17.5 pounds per acre did not give practical control, although worm-free melons were matured at the rate of 750 to 2,080 per acre on the dusted plots as compared with none on the checks. Ten applications of 1-percent rotenone dust, applied at 5-day intervals at 12.5 pounds per acre, gave satisfactory control on cucumbers during a period of favorable weather. Derris gave 93 percent control and cube 79 percent.--Arant (21, 23-26).

In Louisiana rotenone did not give as efficient control of the pickleworm as did cryolite.--Floyd and coworkers (189).

In Mississippi derris dust reduced infestations of the pickleworm on cucumbers in 1940, but it was not determined whether the control obtained justified the expense.--Lyle (372).

Nicotine is ineffective while rotenone is effective against the pickleworm.--McIndoo (383).



In South Carolina some control was given in 1939 on field plots by three applications of a cube dust (1.25 percent of rotenone), but in cage tests with insecticides, including cube, the only one to give any mortality of the larvae was a dust of 10 percent lead arsenate which killed only 51 percent.--Watts (658).

Rotenone has been recommended against the pickleworm on cucumbers, squashes, and cantaloupes in home and victory gardens.--Watson (657); White and Doolittle (683).

Evergestis rimosalis (Guen.), cross-striped cabbage worm

Derris and Tephrosia were more effective than Lonchocarpus of the same guaranteed rotenone content.--Arant (26).

Hymenia recurvalis (F.) (=fascialis (Cram.)), the Hawaiian beet webworm

Derris and other rotenone-bearing dusts were of no value in control of this pest on spinach in Virginia.--Walker and Anderson (642).

In New South Wales, laboratory tests indicated that weekly applications of a dust of 1 pound of derris and 7 pounds of kaolin or talc at 50 pounds per acre would be effective against larvae on the silver beet.--New South Wales Department of Agriculture (440).

Loxostege sticticalis (L.), the beet webworm

In laboratory tests there was no significant difference in effectiveness between dusts containing 0.75 percent of rotenone and 1.5 percent of resins from cube root. Paris green is the standard control in Montana. Small webworms, however, may be killed by pyrethrum, rotenone, or nicotine sprays.--Pepper and Hastings (462, 463).

Maruca testulalis (Geyer), bean pod borer

Dusts and sprays containing rotenone gave inferior results in Puerto Rico in 1940.--Scott (533).

Phlyctaenia rubigalis (Guen.), the celery leaf tier, greenhouse leaf tier

Rotenone was recommended against this pest on celery in Florida.--Watson (657).

Pionea forficalis (L.), garden pebble moth

In England sprays or dusts containing Derris or Lonchocarpus were suggested for the control of this insect on garden crops in 1942.--Walton (653).



Pyrausta nubilalis (Hbn.), the European corn borer

In field plots in Massachusetts treated, respectively, with a dual-fixed nicotine dust and a derris spray, 6 and 5 percent of the plants showed stalk infestation as compared with 36 and 12 percent in the controls. In plots sprayed with dual-fixed nicotine, nicotine tannate, and derris, uninfested ears formed 92.8, 97.6, and 98.3 percent of the total yield, respectively, compared with 70, 94.4, and 94.7 percent in control plots.--Bourne (68).

In Connecticut dahlias were treated with sprays of nicotine, and cube. Both treatments were satisfactory but the cube spray was the least effective. On early and late corn, however, cube and derris sprays were slightly more effective than the nicotine dust.--Britton and coworkers (89).

Sufficient control to enable dahlias to blossom normally was given by a dual-fixed nicotine dust, a derris or cube dust, and a spray of 1 pound of derris or cube (4 percent of rotenone) in 25 gallons of water with a suitable spreader. The rotenone dust was not effective against this insect on sweet corn.--Turner (596).

In New York powdered derris root (5 percent of rotenone), used at the rate of 4 pounds to 100 gallons of water with a suitable spreader, gave good control, 4 or 5 treatments having been necessary to protect the rapidly growing corn plants during the egg-laying seasons.--Hervey and Carruth (282).

In Massachusetts in 1940 percentages of uninfested ears were 81 and 84 for sprays of derris and cube (both 4 percent of rotenone), respectively; 72 and 65 for commercial sprays (4 and 2.5 percent of rotenone); 77, 71, and 76 for a dust of dual-fixed nicotine and two commercial rotenone dusts; and 40 percent for no treatment.--Bourne (69, p. 59).

In 1941 sprays and dusts of derris or dual-fixed nicotine proved of considerable value against the first generation of the corn borer.--Bourne and Whitcomb (74).

Sprays of a proprietary derris preparation did not prevent oviposition of the European corn borer in Japan.--Koo (344).

A mixture of 4 pounds of derris or cube (4 percent of rotenone), 100 gallons of water, and a spreader provided protection for sweet corn.--Caffrey and Baker (98, p. 36).

While four of the many organic compounds tested in 1941 gave the highest reductions in corn borer populations, none of them provided such satisfactory protection to the corn plants as did derris.--Questel and coworkers (485).

Derris (4 percent of rotenone) and synthetic oryolite, each used with a spreader, increased the percentage of uninfested ears in Ontario. The cryolite sprays considerably reduced the number of ears, and caused foliage injury, while derris did not. Five applications of derris were the most profitable of all, and two applications of derris were more profitable than five of cryolite.--Stirrett (572); Stirrett and Thompson (573).

In Connecticut a 1-percent rotenone dust produced about 50 percent of borer-free ears, and dual-fixed nicotine (3.75 percent of nicotine) 66 to 75 percent. The use of derris, cube, or timbo (4 percent of rotenone) in sprays provided control as satisfactory as that of dual-fixed nicotine dust. The cost of spraying was somewhat less than that of dusting. A knapsack bellows duster was better than machine treatment of sweet corn. Encouraging results were given by spraying the ears alone with 1 pound of derris (4.7 percent of rotenone) and 2 ounces of Ultra-wet spreader in 25 gallons of water when young shoots had formed just prior to silking, and later when the ears were in full silk. In spite of the lower cost per acre for rotenone dust, the dual-fixed nicotine dust was distinctly preferable.--Turner (598, 600).

Good control of the corn borer can be obtained with 0.5 percent rotenone dusts, if carefully and thoroughly mixed and applied at the rate of 45 to 50 pounds per acre per application.--Baker and coworkers (32).

Comparisons of pure ground derris and cube roots suspended in water and applied with and without spreading agents showed no consistent differences. Dual-fixed nicotine dust (4 percent of nicotine) was consistently more effective than 1 percent rotenone dusts. Dusts made by impregnating inert materials with extracts of derris were not significantly less effective than dusts made by diluting ground derris root.--Beard and Turner (42); Turner (601).

In Massachusetts the percentages of uninjured ears in untreated plots, and in plots treated with sprays of derris or fixed nicotine and dusts of derris or dual-fixed nicotine, were 92.9, 99.4, 97.1, 99.4, and 98.8, respectively.--Bourne and Whitcomb (76).

In New York the most satisfactory control measure available for the European corn borer in 1942 was four applications, at 5-day intervals, of

a dual-fixed nicotine dust or a 1-percent rotenone dust, which yielded 86.5 and 81.6 percent uninfested ears, respectively, when applied with a wheelbarrow duster, and 90.3 and 89.2 percent respectively, when applied with a tractor duster.--Carruth (104).

Because it appeared probable that rotenone would not be available for use on sweet corn, and the manufacture of dual-fixed nicotine dust was discontinued. A spray of derris (5 percent of rotenone) with Grasselli spreader-sticker was superior to Black Leaf 155, but the latter could be used during the war emergency in situations where spraying was a practical means of borer control.--Carruth (105).

Of the various dust materials tested, dual-fixed nicotine dust (4 percent of nicotine) and 1-percent rotenone dust were the most consistently effective and did not differ greatly in their performances under New York conditions.--Parrott (457).

Nicotine was not entirely satisfactory. Rotenone was more effective against the European corn borer on sweet corn.--U. S. Bureau of Entomology and Plant Quarantine (628).

In 1943 the most satisfactory insecticide for use against this pest in dahlias contained derris, cube, or nicotine.--Batchelder and coworkers (37).

Spray treatments of market sweet corn with high-clearance boom equipment provided greater numbers of borer-free ears, with 40 percent less derris per acre, than did the dust treatments.--Questel and Irons (486).

Differences in tenacity determined in the laboratory indicated that derris dust resisted about six times as much washing as did dual-fixed nicotine dust and it should therefore perform relatively better in seasons of a high amount of rainfall.--Turner (605).

In commercial-scale trials of a derris spray at Toledo, Ohio, and of a derris spray and dual-fixed nicotine dust at New Haven, Conn., at costs of \$19 to \$24 per acre, these treatments showed a new profit of about \$400 per acre from increased yield and reduction in corn borer infestation of early sweet corn.--U. S. Bureau of Entomology and Plant Quarantine (628, p. 133).

In 1944 the conclusions drawn from commercial insecticide tests follow: (1) Derris spray was considerably more effective in corn



borer control than any of the dusts used; (2) derris dusts were more effective than nicotine dusts; (3) none of the dusts tested were satisfactory when dealing with high borer populations; and (4) very heavy infestations can be controlled satisfactorily and profitably in early market sweet corn with derris.--Questel (484).

Rotenone was recommended in 1944 against the corn borer on sweet corn in victory gardens.--White and Doolittle (683).

Rotenone-bearing materials, during the emergency, were permitted to be used against this pest only on sweet corn in home gardens, or for marketing, green. The substitutes were sprays of nicotine ben-tonite and nicotine tannate, and dual-fixed nicotine dust.--U. S. Department of Agriculture (633, p. 14).

#### Saturniidae

Nudaurelia cytherea capensis (Stoll), pine tree emperor moth

Pyrethrum, derris, and dinitro-o-cresol were very promising against larvae of the third, fourth, and fifth instars in South Africa.--Naude (437).

Derris and pyrethrum dusts in South Africa were effective against larvae in the third instar but were considerably less toxic against later instars.--Tooke and Hubbard (594).

#### Sphingidae

Celerio lineata (F.), the white-lined sphinx

In Arizona this pest can be controlled by hand collection and by derris sprays.--Wehrle (668).

Ceratonia catalpae (Bvd.), the catalpa sphinx

The median lethal doses of various insecticides fed in leaf sandwiches to last-instar larvae were expressed as milligrams of a 1-percent rotenone powder as follow: Derris 0.07, Tephrosia 0.07, timbo 0.11, and cube 0.17; and expressed as milligrams of principal toxins (Goodhue rotenone-deguelin values), the doses were 0.0016, 0.0015, 0.0018, and 0.0019, respectively. The data indicated the inadequacy of rotenone content alone to express the insecticidal value of a rotenone-bearing product and emphasized the importance of the Goodhue rotenone-deguelin value as a supplementary expression.--Arant (22, 26).



Pholus achemon (Drury), the achemon sphinx

It can be controlled by hand collection and by derris sprays.--Wehrle (668).

Protoparce quinquemaculata (Haw.), the tomato hornworm

Protoparce sexta (Johan.), the tobacco hornworm

A sweetened liquid bait containing 0.04 percent of rotenone (from aqueous extract of derris or cube) or 5 percent of tartar emetic was taken readily by the moths and was moderately toxic to them. Moths attracted by isocamyl salicylate may be poisoned or trapped in large numbers. Rotenone bait is preferable to one containing tartar emetic because the former is less toxic to humans and livestock.--Scott and Milam (534).

#### Tineidae

Tinea secalella Zacher

A pyrethrum powder (Pyretin) of high quality was by far the best insecticide tested in Sweden. Derris powder was inferior.--Mathlein (403).

Tineola bisselliella (Hüb.), webbing clothes moth

Wollen fabric treated with derris resin was eaten only slightly by the larvae.--Heal (275).

#### Tortricidae

Argyrotoxa semipurpurana (Kearf.), pin oak leaf roller

A derris-rosin residue emulsion gave little control.--Felt and Bromley (177).

Platynota stultana (Wilsn.)

In California pyrethrum-rotenone spray for the control of this insect destroyed the natural bloom of field-grown carnations.--Bohart (63).

Sparganothis pilleriana (Schiff.)

In Germany a spray containing 3 percent of Selinon caused a reduction of 74 percent while one containing 5 percent of Abolin and 1 percent of derris reduced the population only 51 percent.--Jancke (315).

Sparganothis sulfureana (Clem.), sulfur leaf roller

An airplane application of 15 pounds of derris dust (4 percent of rotenone) to the acre was not effective in killing the larvae in New Jersey.--Beckwith (44).

Tortrix pronubana Hbn., carnation tortrix moth

In Scotland the larvae should be sprayed with derris as one of the control measures.--Cameron (99).

#### Zygaenidae

Artona catoxantha (Hmps.), cocoon zygaenid

In central Java damage in a number of outbreak centers was prevented by a single application of derris, but two treatments were necessary to suppress some of the outbreaks. Spraying was regularly practiced, and a suspension containing 0.3 percent of rotenone and 1.5 percent of talc was usually satisfactory. In laboratory tests 100 percent mortality of fourth-instar larvae was obtained with a derris spray containing 0.005 percent of rotenone, and of full grown larvae, with one of twice the strength.--Van der Vecht (636).

Harrisina brillians B. & McD., the western grape skeletonizer

If fruit is present, derris dusts or sprays should be used.--Wehrle (668).

#### Unidentified Lepidoptera

Derride is a normal constituent of derris root. It has a decided killing effect on caterpillars comparable to that of rotenone. A dusting experiment, conducted by Van der Vecht against caterpillars, with derris powder from which the derride had been extracted, indicated that the powder had about the same toxic value as an ordinary sample of derris root with 3 percent of rotenone and 8.1 percent of ether extract.--Meijer and Koolhaas (410).

Due to wartime conditions in Java talc became unavailable for use as a diluent in rotenone insecticides. Three local commercial powders, mixed with sufficient derris to yield mixtures containing 0.75 percent of rotenone, were found to be adequate substitutes for talc in laboratory tests against cabbage caterpillars. "Beta" (a fine powder similar to pumice) and "Te Be Bee" (a clay powder) were more efficient than talc and sufficiently inexpensive.--Verbeek (638).

COLEOPTERA

Anobiidae

Lasioderma serricorne (F.), the cigarette beetle

Derris powder (3.6 percent of rotenone) was highly toxic to the adults in Mauritius.--Jepson (323).

Bostrichidae

Dinoderus bifoveolatus (Woll.)

Three samples of cube root which had been attacked by this beetle were analyzed. The average rotenone content of the whole root was 3.9 percent, while that of the portion of the root changed into powder by the insects was only 1.6 percent.--Jones (326).

Rhyzopertha dominica (F.), the lesser grain borer or Australian wheat weevil

In India lime and cresosote mixed with stored grain gave better results than pyrethrum or derris.--Anonymous (4).

Bruchidae

Bruchus brachialis Fahraeus, the vetch bruchid

Good control of this insect in western Oregon and southwestern Washington was given in field tests by a dust containing rotenone and sulfur.--U. S. Bureau of Entomology and Plant Quarantine (624, p. 27; 628, p. 131).

Bruchus pisorum (L.), the pea weevil

In Oregon a 0.75-percent rotenone dust, applied before the pea weevil oviposited, killed nearly 100 percent of the weevils. This led to the construction of large, hooded dusters mounted on trucks which made possible nearly complete control.--Mote and Thompson (432).

Dusts containing 1 percent of rotenone were more effective than those containing 0.75 and 0.5 percent, but the difference in toxicity between the first and second was less than that between the second and third. A cube dust gave lower mortalities with diatomaceous earth as a carrier than with talc. The toxicity of a cube dust (0.5 percent of rotenone) was increased by the addition of 0.225 percent of pyrethrins.--U. S. Bureau of Entomology and Plant Quarantine (624, p. 62).

This pest can be controlled in green peas and dried peas by use of derris dust mixtures (0.5 to 1 percent of rotenone). Large-scale field tests in 1940 showed that dust mixtures of derris, cube, or timbo (0.75 to 1 percent of rotenone) applied at rates ranging from 25 to 40 pounds per acre gave satisfactory control. A hood or a short trailing canvas on the dusting machine increased the efficiency of the treatment by preventing excessive wind drift.--Brindley and coworkers (88).

Satisfactory control in 1941 was obtained by dusts of derris, cube, or timbo mixed with talc or diatomaceous earth to contain 1 percent of rotenone, and applied at the rate of 20 pounds per acre. As many as three applications may be necessary.--Brindley (87), and Knowlton (343).

The pea weevil can be readily controlled by the application of a 0.75- to 1-percent rotenone dust.--Glasgow (228, 229).

Rotenone dusts were effective, but their successful use requires mechanized dusters and efficient operation. Observations on 13 dusting machines were taken near Moscow, Idaho. In the Palouse area 200,000 pounds of dust were applied, and the weevil dockage on the treated fields was less than 5 percent while on the untreated fields it was 15 percent.--Humphrey (301).

Precautions taken in one district in Utah to prevent infestation by the pea weevil of peas intended for canning included careful examination of the fields by sweeping, dusting with a 1-percent mixture of rotenone and talc at 20 pounds per acre, and removal of chance infested plants just before harvest.--Moss (430).

Tests of different materials as substitutes for derris, cube, or timbo against the pea weevil were unsuccessful although pyrethrum, as well as certain dinitro compounds, might be useful.--U. S. Bureau of Entomology and Plant Quarantine (624, p. 35).

Rotenone dusts applied to peas, for drying, when they came into flower, did not give complete control of the pea bruchid in Washington, and fumigation of the harvested crop was therefore necessary. The use of rotenone on Austrian peas grown for seed was prohibited in 1942 in order to conserve the supplies of rotenone for crops used as human food, and fumigation was compulsory.--Webster and Eichmann (663).

In 1942 rotenone was the standard insecticide for the pea weevil. Nicotine was ineffective.--U. S. Bureau of Entomology and Plant Quarantine (628); McIndoo (383).



Instructions in 1943 to victory gardeners stated that rotenone was scarce, and restricted to use on peas for the pea weevil, and for a few other insects. A spray of sodium fluosilicate and sugar might supplement rotenone dust to control the pea weevil on Austrian peas.--U. S. Bureau of Entomology and Plant Quarantine (630; 628, p. 135).

One of the most important uses for rotenone is to control the pea weevil.--Howard and coworkers (294, p. 30).

In 1944 rotenone was still recommended against the pea weevil in victory gardens.--White and Doonittle (683).

There is no comparable substitute for rotenone for control of the pea weevil.--U. S. Bureau of Entomology and Plant Quarantine (633).

Callosobruchus maculatus (F.), the cowpea weevil

Rotenone was recommended against this pest on cowpeas in Florida in 1943.--Watson (657).

#### Buprestidae

Agrilus rabricola Abeille, the bronze cane borer

Agrilus ruficollis (F.), the red-necked cane borer

In New York in 1941 derris dusts gave promise of satisfactory control, and in 1942 a derris spray was effective.--Mandinger (434, 435).

In New York State the following sprays are recommended: (1) lead arsenate 5 pounds, and  $\frac{1}{2}$  pound of soybean meal or skim milk powder to serve as a spreader and sticker; (2) powdered derris or cube (4 to 5 percent of rotenone) 5 pounds, with the preceding spreader and sticker, per 100 gallons.--Slate and coworkers (544, p. 54).

Sometimes a single, well-timed application of rotenone will give good repression, but usually two spray applications of lead arsenate or of derris (5 pounds per 100 gallons) are necessary for the best results.--Parrott (457) in 1942.

## Byturidae

Byturus tomentosus (Deg.), a raspberry and loganberry beetle

Byturus rubi Barber or bakeri Barber (=unicolor Say), a raspberry fruitworm

Three applications of derris, cube, or timbo, either as a dust or spray, were recommended as a control of the raspberry or loganberry fruitworm (B. unicolor) in Washington. The dust should contain not less than 0.5 percent of rotenone mixed with talc or diatomaceous earth as a carrier. If a spray was to be used, 34 ounces of derris, cube, or timbo (4 percent of rotenone) were required for each 100 gallons. Rotenone was the only remedy recommended.--Hanson and Webster (260).

Rotenone is the standard or preferred insecticide for the raspberry fruitworm. Nicotine is ineffective.--U. S. Bureau of Entomology and Plant Quarantine (628).

Derris is particularly suitable for the control of the raspberry beetle.--Freak (199).

Powdered derris or cube (4 to 5 percent of rotenone) used at the rate of 3 to 5 pounds in 100 gallons of water with  $\frac{1}{2}$  to 1 pound of soybean meal or other neutral spreader, may be substituted for lead arsenate spray. A 1-percent rotenone dust was also effective against raspberry beetles in New York.--Slate and coworkers (544, p. 49).

The raspberry fruit worm has been controlled fairly well by the use of rotenone.--U. S. Bureau of Entomology and Plant Quarantine (628, p. 802).

There is no comparable substitute for rotenone. Lead arsenate is of some value for early treatments but should not be used after the berry blossoms open.--U. S. Department of Agriculture (633, p. 15).

## Cantharidae

Cantharis obscura L.

In France tests against this insect on fruit trees with sprays of nicotine, rotenone, or pyrethrum, and dusts of talc containing 0.75 percent of rotenone from Derris elliptica, and of a mixture of sulfur and lime, demonstrated that the best results were given by the rotenone dust.--Feytaud and Chaboussou (183).

Cerambycidae

Oberia bimaculata (Oliv.), the raspberry cane borer

In New York best results were obtained with a spray containing 5 pounds of derris (4.8 percent of rotenone) and  $\frac{1}{2}$  pound of soybean meal per 100 gallons of water, 1 application of which gave 90.8 percent control. One or 2 applications of a 1-percent rotenone dust, and 2 applications of a spray containing 1 pint of a commercial rotenone extract (2.5 percent of rotenone) in 100 gallons of water were less effective.--Mundinger (435); Slate and coworkers (544, p. 54).

This borer was controlled best by rotenone sprays, and moderately well by rotenone dust.--Parrott (457).

Saperda candida F., the roundheaded apple tree borer

In New York insecticides were injected into larval tunnels in apple trees. One and five-tenths percent of rotenone extract with ethyl alcohol (1:4), caused 71 percent mortality, while 5 percent rotenone extract in acetone, caused 100 percent mortality of the larvae.--Hess (283, p. 81).

Unidentified cerambycids

Longhornes are important pests of fig trees in Japan. In tests lead arsenate, pyrethrum, and derris were injected into the mines of these insects in the stems and branches of fig trees. The best results were given by the arsenate and pyrethrum, which killed 96 and 83 percent of the larvae, respectively.--Kusunome and Umetsu (346).

Chrysomelidae

Agelastica alni (L.), an elder beetle

This insect, attacking fruit trees in France in 1939, was controlled by arsenical sprays. Preparations containing rotenone and pyrethrum also gave good results.--Feytaud (181).

(Ceratia) Aulacophora hilaris (Boisd.)

In New South Wales cucurbit plants can be dusted with derris, or a mixture of pyrethrum and flour (1:4), both of which destroy many of these beetles and prevent reinfestation for 1 or 2 days.--New South Wales Department of Agriculture (441).

In South Wales plants may be dusted with a mixture of pyrethrum and kaolin or flour (1:4), Derris dust may also be used.--New South Wales Department of Agriculture (444).



Betophila (Glyptina) rubi (Payk.)

This beetle which injures strawberry leaves in Norway was readily controlled by derris.--Schryen(526).

Brontispa limbata (Waterh.)

Experiments showed that derris (3.6 percent of rotenone) grown in Mauritius was highly toxic to the adults.--Jepson (323).

Cassida nebulosa L.

Derris dust was more effective than lead arsenate against this beetle on beets in Switzerland.--Roos (514).

Cassida viridis L.

Good results in Rumania were obtained by spraying cultivated mint with lead arsenate, or dusting with calcium arsenate, but since arsenicals should not be applied to medicinal plants, dusting with derris preparations is preferable.--Manolache and coworkers (392).

Cerotoma trifurcata (Forst.), the bean leaf beetle

Rotenone is the standard remedy. Nicotine is ineffective.--U. S. Bureau of Entomology and Plant Quarantine (523).

Rotenone was recommended against this beetle on beans, and on field peas if the pods are to be eaten green.--Maxwell (407); White and Doolittle (683).

Chrysocbus auratus F.

Derris and Tephrosia were more effective than Lonchocarpus of the same guaranteed rotenone content.--Arant (26).

Colaphellus bowringi (Baly), a large cabbage leaf beetle

In cage tests in China insecticides, prepared from the root bark and leaves of Millettia reticulata, killed 100 percent of the adult beetles as a stomach poison, but were unsatisfactory as a contact poison against mature larvae.--China Agricultural Research Bureau (112).

Crioceris asparagi (L.), the asparagus beetle

In South Carolina cage tests with dusts indicated that undiluted calcium arsenate was slightly superior to a 0.75-percent rotenone dust against the larvae, but the rotenone was superior for the adults.--Watts (659).



In Washington commercial rotenone dusts (0.5 to 1 percent of rotenone) and pyrethrum dusts (0.1 to 0.2 percent of pyrethrins) gave practically complete mortality of this pest on asparagus 3 days after treatment. A dust of 10-percent calcium arsenate in pyrophyllite was cheap and effective, but comparable results were given by dusts containing 0.5, 0.75, or 1 percent of rotenone.--Webster and Eichmann (662).

In Wisconsin a 0.1-percent rotenone dust was effective.--Wilson and Janes (689).

In order to conserve the supply of rotenone it was recommended that a 0.75-percent rotenone dust be substituted for the 1-percent dust used for the control of asparagus beetles.--U. S. Bureau of Entomology and Plant Quarantine (626).

One of the more important uses of rotenone is to control the asparagus beetle.--Howard and coworkers (294, p. 31).

There is no adequate substitute for rotenone in the control of the asparagus beetle. Arsenicals are unsatisfactory on edible shoots because of the residue hazard.--U. S. Department of Agriculture (633).

Diabrotica duodecimpunctata (F.), the spotted cucumber beetle, southern corn rootworm

Rotenone was recommended against this species in North Carolina in 1943.--Maxwell (407).

Diabrotica undecimpunctata Mann. (= soror Lec.), the western spotted cucumber beetle

In California a dust containing 0.5 percent of rotenone and 2 percent of Lethane in talc gave inconclusive results, chiefly because many of the beetles flew from the fruit trees as soon as the dust was applied.--Michelbacher and coworkers (417).

The western spotted cucumber beetle can be destroyed with a 1-percent rotenone dust.--Rockwood and Chamberlin (510).

Diabrotica spp., cucumber beetles

In Louisiana a 1-percent rotenone dust did not give so efficient control as did cryolite.--Floyd and coworkers (189).

In California derris was applied by airplane to cucurbit plants, with considerable success.--Lockwood (370).

One of the more important uses of rotenone is to control cucumber beetles.--Howard and coworkers (294, p. 31).

Rotenone and copper-rotenone are considered fair for cucumber beetles in victory gardens.--Reed (496).

Pyrethrum can be substituted for rotenone to control cucumber beetles.--Turner and Horsfall (606).

Rotenone was recommended against cucumber beetles on beans, cantaloupes, cucumbers, and squashes in victory gardens in 1944.--White and Doolittle (683).

Diabrotica vittata (F.), the striped cucumber beetle

A derris dust containing 0.6 percent of rotenone is recommended over other treatments, for it serves not only as a repellent but as a stomach and contact poison as well.--Beard (39).

In Massachusetts a spray of 4 pounds of wettable cube powder (3.65 percent of rotenone) in 100 gallons of water reduced the beetles 90 percent, and a cube-clay dust (0.6 percent of rotenone) reduced them 85 percent.--Bourne and Whitcomb (73).

In Wisconsin a derris dust (0.6 percent of rotenone) was the most effective insecticide in controlling the striped cucumber beetle. Fluosilicates, arsenicals, and nicotine dusts were less effective in the order named.--Brooks and Allen (92).

A combination of insoluble copper, wheat flour, and pyrophyllite, in which rotenone was the active ingredient, gave some promise. The use of a fungicidal and insecticidal combination dust is desirable in Maine.--Hawkins (272).

Rotenone dusts and derris sprays were effective in New York.--Hervey (279).

When calcium arsenate and rotenone were used separately, each brought about a marked increase in yield of cucumbers.--Parrott (457).

Derris dusts (0.5 to 0.75 percent of rotenone) were the most effective insecticide tested against this pest in Mississippi.--Lyle (372).

In all tests the mortality following use of 0.25 percent of rotenone with pyrophyllite was higher than from 2 percent of rotenone with fibrous talc or clay. In regard to flaky talc and slate dust,

1 percent of rotenone was required to equal 0.25 percent of rotenone with pyrophyllite. The dosage for equal control of the striped cucumber beetle was approximately 4 to 1 in favor of pyrophyllite.--Turner (602).

Sprays and dusts of rotenone materials and of calcium arsenate were recommended in 1941. In February 1942 a dust containing 0.75 percent of rotenone was recommended in place of the 1 percent rotenone dust.--U. S. Bureau of Entomology and Plant Quarantine (622; 626, p. 5).

In Massachusetts dusts were applied eleven times in 1940. Calcium arsenate was the most effective. Cube with talc (0.75 percent of rotenone) and rotenone dust (0.8 percent) gave at least 80 percent reduction of the beetle population on cucumbers, and 90 percent on cantaloupes. In 1941 most of the insecticides applied eight times gave at least 90 percent control. The most effective ones contained rotenone or calcium arsenate. In 1943 rotenone-"copper oxychloride sulfate" dusts containing 0.75 and 0.5 percent of rotenone were about equally effective against the striped cucumber beetle; the 0.75-percent rotenone dust gave slightly better protection on cucumbers, and the 0.5-percent dust on melons. The 0.5-percent dust, if available, will be satisfactory.--Whitcomb (676, p. 48; 677, p. 61; 681, p. 35).

A mixture of 12 pounds of derris and 88 pounds of dusting sulfur gave consistently better results than any other combination tested, but burned melon plants. A mixture of 12 pounds of derris and 88 pounds of talc ranked second in control.--Wisconsin Agricultural Experiment Station. (694).

Disomycha xanthomelasma (Dalman), the spinach flea beetle

Rotenone is effective; nicotine is ineffective.--McIndoo (383).

Rotenone is recommended against this pest.--Maxwell (407), and White and Doolittle (683).

Epitrix cucumeris (Harr.), the potato flea beetle

In Massachusetts Cubor and derris mixed with bordeaux mixture gave the greatest reduction in leaf punctures on potatoes.--Bourne (68).

In Connecticut a cube dust (0.75 percent of rotenone) was more effective than a spray of 1 pound of cube (4 percent of rotenone)



in 25 gallons of water, or a dust of barium fluosilicate and hydrated lime (1:4). The addition of a petroleum sulfonate (Ultrawet) to the cube dust (1:1000) increased its effectiveness and reduced the feeding of the beetles.--Connecticut Agricultural Experiment Station (120, p. 299).

All dusts tested against this species on shade-grown tobacco were more effective than the sprays, and gave significant reductions. On the sun-grown tobacco, pyrethrum dust was more effective than the cube dust, which was more effective when it contained no wetting agent.--Morrill and Lacroix (427).

Newly set tomato and eggplants may be protected from flea beetle damage by dusting them three times weekly with cube dust (0.75 percent of rotenone).--Turner (597).

In Connecticut in 1941 the most satisfactory control of this pest was obtained with a cube-tobacco dust mixture containing 1 percent of rotenone, and with an impregnated pyrethrum powder. Prior to 1936 commercial damage caused by *E. cucumeris* to shade-grown, cigar-wrapper tobacco was estimated at 20 to 50 percent. In 1940 the growers estimated this damage to have been reduced to 1 to 2 percent by the use of a dust mixture containing 1 percent of rotenone.--Morrill (425); Morrill and Lacroix (428).

NNOR, consisting of technical mammitan monolaurate, rotenone (1 percent), and other derris extractives (1.8 to 2.6 percent) was tested against the potato flea beetle on eggplant. Dilutions (1:1200) gave 86 percent mortality.--Roth and Pyenson (517).

A "3-way" dust of pyrethrum, rotenone, and sulfur gave increases in yield of potatoes from 70 to 90 bushels per acre. The rotenone caused a significant reduction in flea beetles and aphids.--Skaptason and Blodgett (542).

Derris and Syntone in combination with bordeaux mixture gave a high initial kill, and the potato foliage treated with these materials was relatively free from flea beetle injury.--Anderson and Walker (18).

To control this pest on tomato plants, in seedbeds or on newly set plants, it was recommended in 1942 to use a derris or cube-talc dust mixture containing 1 percent of rotenone.--Beattie and coworkers (43).

Flea beetles on tobacco in plant beds in Florida and Georgia can be controlled by a cube or derris dust (1 percent of rotenone). A mixture of this dust and sterilized tobacco dust containing 1 percent of rotenone should be applied soon after the plants are set in the field and thereafter at weekly intervals.--Chamberlin and Madden (109).



The general use of pyrethrum-sulfur or rotenone-sulfur combinations against flea beetles and aphids on potatoes may be limited by their failure to prevent late blight, and by their higher costs.--Jaines and coworkers (134).

The control of flea beetles on tomatoes by derris increased the control of the early blight fungus by reducing the dissemination of the spores and the number of feeding punctures. Effective control of the blight where beetles are present early should be achieved by applications of copper and derris while the beetles are present, followed by copper alone after they have disappeared.--Heuberger (284).

In Connecticut there was no significant difference in effectiveness between the three treatments tried--pyrethrum dust alone, pyrethrum followed by cube, and a 1-percent rotenone dust.--Morrill and Lacroix (429).

In New York the addition of pyrethrum and rotenone-bearing powders to bordeaux mixture increased both the control of E. cucumeris and the yields. Cube dust (0.75 percent of rotenone) was effective.--Rawlins and Staples (492); Rawlins and coworkers (493).

Calcium arsenate dust was the most effective of the materials tested against the potato flea beetle in field tests in the Pacific Northwest. Dusts containing zinc arsenite and certain fluorine and rotenone compounds gave fairly good control after eight applications.--U. S. Bureau of Entomology and Plant Quarantine (624, p. 35).

In Washington control of larvae on potato tubers was given by four to six applications of calcium arsenate or cryolite dust. A mixed dust of rotenone and cryolite was more rapid in action, but the cost was high.--Webster and Coworkers (664).

One part of derris suitably diluted with pyrophyllite was as effective as 2.5 to 5 parts of derris diluted with clay.--Turner (602).

In experiments in which counts were taken 3 days after setting out tomato plants, both derris dust and derris spray gave satisfactory results against the potato flea beetle.--Watkins and Logan (656).

Epitrix parvula (F.), the tobacco flea beetle

Note: Two species Epitrix hertipennis (Meesh) and E. fasciata Blatchler have been confused in our literature under the name E. parvula.

In South Carolina effective control was obtained by a thorough application of 10 pounds per acre of cube dust (1 percent of rotenone). Dust mixtures containing rotenone and cryolite gave good plant protection, but the cryolite gave the best protection over a period of days. Results obtained over a 5-year period showed that this pest can be controlled in tobacco plant beds, or in the field by cube or derris dust mixtures (1 percent of rotenone) which remain effective for 2 or 3 days. A thorough application of a spray of 2 pounds of cube (4 percent of rotenone) in 50 gallons of water controlled it. Some late-season tests on individual tobacco plants indicated that a cube dust mixture (1 percent of rotenone) gave good control, although a cryolite dust mixture (80 percent of sodium fluoaluminate) gave better plant protection over a period of 6 days. --Allen and coworkers (12, 13); Allen (10); Allen and Shands (14).

Mixtures of cube or derris and sterilized tobacco dust containing 1 percent of rotenone controlled the tobacco flea beetle. They should be applied soon after the tobacco plants are set in the field and thereafter at weekly intervals. One application per week or a total of eleven for the season gave the most economical control under conditions of heavy infestation on cigar-wrapper tobacco, while one application every 10 days, or a total of three per season was sufficient for a very light infestation.--Chamberlin and Madden (108, 109).

No substitute for rotenone has been found for the control of flea beetles on shade-grown tobacco in Florida.--U. S. Bureau of Entomology and Plant Quarantine (628, p. 136).

A derris compound used in the laboratory was much more effective against the tobacco flea beetle than Dutox or cryolite.--Wene and Dominick (674).

#### Fidia viticoida Walsh, the grape rootworm

In Arkansas the adults may be destroyed during the preoviposition period of about 2 weeks with one or two grape sprays of 1.5 pounds of derris (4 percent of rotenone) in 50 gallons of water.--Isely (312).

#### Galerucella xanthomelaena (Schr.), the elm leaf beetle

In New York derris powder, 2 pounds with a wetting agent, gave good control. This was a standard with which various rotenone extracts and cube were compared.--Parrott (457).

Leptinotarsa decemlineata (Say), the Colorado potato beetle

A 10-percent yam bean dust killed 100 percent of the larvae in less than a day, but sprays containing up to 8 pounds of ground yam bean per 100 gallons of water were less effective than 1 pound of 5 percent cube in spray.--Anonymous (7).

In laboratory tests, derris, cube, timbo, and Tephrosia virginiana, mixed with talc or sulfur to give 0.5 percent of rotenone, were very effective.--Arant (22, 26).

In laboratory tests using 10 fourth-instar larvae in each experiment, records were made of the exact time at which the different symptoms of the poisoning and paralysis of the larvae took place. When dusts containing 0.5 percent of rotenone, used as contact poisons, were compared by this method, derris proved superior to cube, and cube to timbo, but preparations of derris, cube, or timbo differed among themselves. The toxicity of cube dust was affected by the carrier used with it. The time required for larvae to become completely paralyzed varied with the temperature. In tests with cube dust (6 percent of rotenone) alone, or diluted with talc to contain 0.9 percent of rotenone, there was no great difference in rate of action of the two dusts at any one temperature, but the talc appeared to exert a desiccating effect that assisted the lethal action of the rotenone. High temperatures accelerated the action. The application of rotenone dusts during the warmest part of the day is therefore recommended. The effectiveness of the cube-talc mixture was unaffected by darkness.--De Lapparent (355); Feytaud and De Lapparent (184).

When use of arsenicals is undesirable in France, potatoes may be dusted with derris or cube, but the cost is higher. The necessity of common action is emphasized if the potato beetle is to be controlled.--Feytaud (182).

The best preventive measure in Europe is to spray all potato fields with lead or calcium arsenate. In situations where the use of arsenicals is dangerous, dusts or sprays of nicotine or rotenone should be used.--Mayne (409).

Rotenone or rotenone plus Bordeaux mixture, is considered good for the potato beetle in victory gardens in Indiana.--Reed (496).

Derris-talc dusts were effective and acted quickly in Germany, but derris sprays were not so effective.--Sellke (535).

A mixed spray, consisting of bordeaux mixture and lead arsenate, is recommended in Switzerland. Places where potato beetles are actually found should be treated with derris powder to kill any larvae falling to the ground. The derris treatment is the only one possible where there is danger of poisoning from vegetables.--Wahlen (641).

Lochmaea saturalis (Thoms.)

This insect injures heather in Scotland. An outbreak may be prevented by dusting with derris or pyrethrum while the infested area is still small.--Morison (424).

Luperodes brunneus (Crotch), corn silk beetle

In Louisiana the beetles are easily killed by arsenicals or cryolite, but dusts of nicotine, derris, or pyrethrum are only partially effective.--Eddy (158).

Phyllotreta atra F., a flea beetle

A derris dust (Kumex) containing 0.8 percent of rotenone killed almost all the beetles on rape in field tests when it was applied at 22.5 pounds per acre.--Kaufmann and Frey (337).

Phyllotreta spp.

Kumex was effective against cabbage flea beetles in Germany.--Frey (200).

Repellent dusts containing naphthalene, and insecticidal dusts containing nicotine or derris, have been used widely in recent years against turnip flea beetles on crucifers in Britain. They have given satisfactory results but their effectiveness depends on proper timing.--Miles (418).

Phyllotreta undulata Kutsch.

Kumex killed nearly 100 percent on rape in Germany.--Kaufmann and Frey (337).

Phyllotreta vittata discodens Weise

A cube-sulfur dust containing 0.4 percent of rotenone would effectively control this flea beetle on the Texas Gulf Coast. A spray of cube powder and water was equally as effective as a cube dust.--Janes (316, 317).



Promecotheca papuana Csiki, the coconut leaf miner

In tests with dusts in New Guinea lead arsenate gave the highest mortality, while derris and pyrethrum gave very poor results.--Froggatt (203); Froggatt and O'Connor (205).

Psylliodes attenuata (Koch), hop flea beetle in England

This insect on hops can be controlled by derris dusts, applied in May.--Massee (400, 401).

Psylliodes chrysocephala (L.), rape flea beetle in Europe

In Holland results of tests on the adults with derris were inconclusive.--Van Poeteren (469, p. 47).

In East Holstein experiments with proprietary dusts against the adults on rape showed that a derris preparation was most effective, followed by a mixture of pyrethrum and derris.--Meuche (412).

In Germany Künex was effective.--Frey (200); Kaufmann and Frey (337).

Rhapidopalpa foveicollis Lucas, red melon beetle

In Palestine the adults on melons may be controlled by two or three applications of a derris dust (0.75 percent of rotenone).--Anonymous (2).

Unidentified flea beetles

Flax in France can be protected from flea-beetle attacks by the use of rotenone powder.--Martin and Verrie (396).

In England a farmer did not lose a crop from the ravages of flea beetles for 10 years. On the first appearance of the pests on a crop he dressed it with 3 pounds per acre of the best derris powder (not derris dust). The machine used to spread this small amount per acre was devised from an old horse rake.--Willetts (684).

Pyrethrum can be substituted for rotenone to control flea beetles in Connecticut.--Turner and Horsfall (606).

Rotenone is preferred for flea beetles on miscellaneous crops. Nicotine is ineffective. To control flea beetles, a 0.75-percent rotenone dust was recommended to replace the 1-percent dust commonly used.--U. S. Bureau of Entomology and Plant Quarantine (626, p. 5).

Sprays containing 0.1 percent of nicotine were extensively and successively used in East Prussia, because derris and pyrethrum were scarce.--Janisch (319).

Rotenone was considered fair, and rotenone with a copper fungicide good, for flea beetles in victory gardens in Indiana.--Reed (496).

One of the more important uses of rotenone is to control flea beetles on vegetables, flowers, and fruits. Substitutes are: bordeaux mixture, although much inferior; calcium arsenate, cryolite, and barium fluosilicate.--U. S. Department of Agriculture (633, p. 14).

#### Coccinellidae

Epilachna chrysomelina F., 12-spotted ladybird beetle

In Palestine the larvae on cucurbits were easily controlled by barium fluosilicate or sodium fluosilicate, and the adults by derris dusts.--Anonymous (2).

Epilachna varivestis Muls., the Mexican bean beetle

In Maine in 1940 rotenone was practically as effective as calcium arsenate, but did not remain effective as long as the arsenate. Rotenone dusts without wetting and spreading agents were effective and were safe to use on beans, both from the standpoint of injury to the beans, and human safety.--Hawkins (271, 272).

In Louisiana the best insecticidal treatment leaving no residue on the bean plants was a derris or cube dust (1 percent of rotenone), applied at the rate of 15 to 25 pounds per acre at weekly intervals when the bean beetle was active. Cryolite at 10 to 15 pounds per acre can be used until the bean pods begin to form.--Eddy (159).

In laboratory tests with derris, cube, timbo, and Tephrosia virginiana, mixed with talc or sulfur to give a 0.5 percent rotenone content, cube gave 10 percent lower kill than the other dusts, killing only 70 to 90 percent of bean beetles in 72 hours, compared with 100 percent for the other dusts. In other comparative tests with commercial samples of derris, timbo, and cube, and samples of powdered tephrosia roots, derris and tephrosia were more effective than lonchocarpus of the same guaranteed rotenone content.--Arant (22, 26).

Certain new coal tar insecticide dusts were as effective as a 0.75 percent rotenone dust.--Ferguson (180).

Under greenhouse conditions on Long Island a large percentage of the larvae and adults survived 5 days' exposure to the presence of derris powder sprayed on foliage and little feeding took place. The insect was able to distinguish between sprayed and unsprayed foliage. Derris sprays were lethal when larvae and adults were directly hit in spraying. Otherwise their effectiveness, when applied for purposes of ingestion, was dependent on their repellent properties. The results of field experiments conducted in 1936 to 1941 on lima beans showed that dusts containing rotenone were more effective than those containing pyrethrum. The addition of rotenone to the dusts of copper sulfate and lime improved foliage protection, but had practically no effect on yield. In 1940 and 1941 pyrethrum tended to give better yield than rotenone.--Huckett (297, 299).

A study of the compatibility of cube combined with bordeaux mixture was conducted in Ohio. The colorimetric analyses and tests with goldfish indicated a 20 percent reduction in rotenone content of the mixture after 30 days, 40 percent after 62 days, and 50 percent after 92 days, but no further change was detected even after 12 months. In the field, a bordeaux-cube combination, originally made up to contain 0.02 percent of rotenone, but which had deteriorated about 50 percent in rotenone content at the time of application, was tested against the bean beetle. It appeared equal in effectiveness and residual effect to a cube spray containing 0.015 percent of rotenone.--Fulton and Nelson (207).

In New York a 0.75-percent rotenone dust, applied at the rate of 30 pounds per acre of beans, was the most effective of the insecticides tested, and a spray containing rotenone and skim milk powder was more effective than one of nicotine sulfate in summer-oil emulsion. Significant increases in yield of field beans were obtained by dusting with Alorco cryolite, copper arsenate-lime (1:4), or with a 0.75 rotenone dust.--Schwardt and Ramsay (528, 529).

In February 1942 the use of a 0.5-percent rotenone dust, applied at the rate of 20 to 25 pounds per acre per application, was recommended.--U. S. Bureau of Entomology and Plant Quarantine (626).

Pyrethrum was suggested as a substitute for rotenone. Instructions to victory gardeners stated that rotenone was restricted in 1943 to use against the bean beetle and a few other insects.--U. S. Bureau of Entomology and Plant Quarantine (626, 630).

A dust containing Cuprocide (G.A.) 6 percent, dusting sulfur 30 percent, derris (5 percent of rotenone) 15 percent, and pyrophyllite 49 percent, was effective on Long Island.--Cunningham (131).



In a study of diluents with derris, preliminary results indicated the following relative rating: Talc, sulfur, pyrophyllite, and redwood-bark flour.--Davis (135).

In Connecticut, Lethane increased the toxicity of derris and cube. In dust mixtures an improper diluent may decrease the toxicity of the insecticide, as do certain clays when mixed with rotenone-bearing materials. Ground derris root (4 percent of rotenone) was diluted with pyrophyllite and then tested against larvae of the Mexican bean beetle. The reduction in number of larvae per plant with a 1-percent rotenone content dust was 99.7 percent; with a 0.5-percent dust, 99.3 percent; with a 0.25-percent dust, 98.9 percent; with a 0.125-percent dust, 88.6 percent; and with a 0.0625-percent dust, 69.9 percent.--Friend (202, p. 210).

In Maryland the average yields of shelled lima beans were 89.6 pounds for a 0.75-percent rotenone dust which was effective against the bean beetle, and 83.5 pounds for a 0.4-percent rotenone dust with Lethane which gave fair control.--Graham and Ditman (240).

To prepare a spray for bean beetle control, use  $3\frac{1}{4}$  pounds of rotenone roots (4 percent of rotenone), or  $2\frac{1}{2}$  pounds of rotenone roots (5 percent of rotenone) to 100 gallons of water. For smaller quantities use 1 ounce of 4-percent powder to 2 gallons of water or 1 ounce of 5-percent powder to  $2\frac{1}{2}$  gallons. This mixture will contain approximately 0.015 percent of rotenone.--Howard and coworkers (294, p. 31).

The seeds of the yam bean (Pachyrhizus erosus Urban), used as a dust, killed 100 percent of first-instar larvae within 48 hours. An examination of 12 samples from the Western Hemisphere, using 20 percent of ground beans in talc, showed consistently high kills of larvae in the laboratory.--Hansberry and Lee (258).

The stems and seeds of Milletia pachycarpa Benth. and Pachyrhizus erosus Urban applied as dusts killed practically all the first-instar bean beetle larvae tested.--Lee and Hansberry (360).

In Colorado calcium arsenate spray, rotenone dust, and 0.2 percent pyrethrin dust gave yields not significantly different from that of zinc arsenite. Rotenone appeared more effective as a spray than as a dust.--List (367).

A home-made rotenone dust may be prepared with derris or cube powder (4 percent of rotenone) 1 pound, and talc, flour, tobacco dust, or dusting sulfur, 7 pounds.--Maxwell (407).



Sprays and dusts containing rotenone or copper-rotenone were recommended for the Mexican bean beetle in victory gardens in Indiana.--Reed (496).

In terms of dosage for equal control at the 90 percent level for larvae, 0.15 percent of pyrethrins equalled 0.08 percent of rotenone in derris dust. In dosage studies to compare two diluents for derris, the dosage-response curves for protection of bean foliage from injury were much flatter than the curves for actual control of the bean beetle. One part of derris suitably diluted with pyrophyllite is as effective as 2.5 to 5 parts of derris diluted with clay. Dusts or sprays of rotenone should be applied to the under surface of the bean leaves.--Turner (602, 604); Turner and Horsfall (607).

Dusts containing 2 percent of Lethane and 0.4 percent of rotenone were as effective as dusts containing 0.75 to 1 percent of rotenone.--Anonymous (8, 9).

In 1944 rotenone was still recommended against the Mexican bean beetle in victory gardens, although as partial substitutes cryolite, pyrethrum, calcium arsenate, magnesium arsenate, zinc arsenite, barium fluosilicate, and sodium fluosilicate could be used under certain conditions.--White and Doolittle (683); U. S. Department of Agriculture (632, p. 15).

#### Cucujidae

Oryzaephilus surinamensis (L.), the saw-toothed grain beetle

Adults are susceptible to the rotenone class of insecticides.--Tattersfield and Potter (583).

#### Curculionidae

Anthonomus eugenii Cano, the pepper weevil

A cryolite-talc-cube dust mixture was used at the rate of 15 to 25 pounds per acre per application in California. The treated fields produced more than three times as many pods as the untreated fields. It was estimated that 3,570 acres of peppers were treated, bringing the total net profit to \$594,370. The use of calcium arsenate to control the pepper weevil caused increases in aphid populations.--Campbell and Elmore (102); Elmore and Campbell (163).

Anthonomus grandis Boh., the boll weevil

Various combinations of insecticides were tested against the boll weevil and cotton aphid in Louisiana. In one test calcium arsenate plus 10 percent of sulfur, and 0.5 percent of rotenone was used, but it is not stated what effect the rotenone had on the weevil.--Beckel and Floyd (45).

Calcium arsenate-sulfur mixtures with derris effectively controlled the cotton aphid and boll weevil in Mississippi.--McGarr (381).

Barium fluosilicate plus derris (to give a 0.5-percent rotenone content) was significantly better than two of the three oryolites tested with or without the addition of derris for boll weevil control. In a second report, the materials tested were calcium arsenate, with and without derris, and equal parts of calcium arsenate and sulfur, with and without derris. No significant difference in the degree of boll weevil control was observed between any two insecticides in South Carolina.--Rainwater and Bondy (490, 491).

Anthonomus musculus Say, the cranberry weevil

In Massachusetts a single application of a spray containing 15 pounds of derris powder (4 percent of rotenone) and  $\frac{1}{2}$  pound of Areskap per 100 gallons of water, at the rate of 400 gallons per acre of cranberries, failed to give a good kill.--Franklin (192).

Anthonomus pomorum (L.), an apple blossom weevil

In Germany dusts containing dinitro-o-cresol were superior to a dust containing derris and pyrethrum.--Thiem (587).

Anthonomus pyri Koll. (cinctus Redt.), a pear blossom weevil

In Germany a preparation of pyrethrum and derris gave good control at a high concentration, but one of derris alone was ineffective.--Jancke (313); Thiem (588).

Anthonomus rubi (Hbst.), a strawberry blossom weevil

In Germany this pest on strawberry plants is best controlled by a derris dust, or a mixture of derris and pyrethrum at the rate of 27 pounds per acre during time of maturation feeding in late spring.--Reimann (501).

Anthonomus signatus Say, the strawberry weevil

In Delaware a derris dust (0.5 percent of rotenone) had only a slight effect on the adults.--Amos and Beacher (16).

Apion spp., clover seed weevils

In England applications of derris dust destroyed many weevils on clover.--Staniland and Beaumont (563).

Brachyrhinus ligustici (L.), the alfalfa snout beetle

In New York a 1-percent rotenone dust was tried, but the most satisfactory control material was a raisin bait containing shorts and sodium fluosilicate.--Palm and coworkers (454).

Ceutorhynchus assimilis (Payk.), the cabbage seedpod weevil

In western Washington infestation of cabbage by this insect, in experimental plots was reduced about 20 percent by two applications of a dust containing derris, wheat flour, talc, and a wetting agent.--Breakey and Webster (85).

Conotrachelus crataegi Walsh, the quince curculio

In Connecticut when monthly applications of lead arsenate and dry lime sulfur were followed by six applications of a spray containing derris and skim milk powder, 80 percent of the fruits on quince trees were uninjured by the oriental fruit moth and this curculio.--Garman (218).

Conotrachelus nenuphar (Hbst.), the plum curculio

In experiments with this pest on peach trees in Pennsylvania acid lead arsenate was only slightly more effective than basic lead arsenate or cube, but three sprays did not greatly reduce the number of larvae that matured when compared with unsprayed checks.--Steiner and Worthley (566).

Cosmobaris americana Casey=(Baris scotopacea Germ., a snout beetle

In Massachusetts preliminary trials with rotenone dust indicated that this treatment will reduce the abundance and destructiveness of this pest on Swiss chard.--Whitcomb (679, p. 39).

Diaprepes spp., citrus weevils

The use of Tephrosia candida in Trinidad and St. Lucia as a

cover crop was recommended because this plant was definitely unattractive to the weevils and poisoned those that fed on it. It was found that this plant contains a toxic principle which is present in decreasing quantities in the seeds, stems, root-cortex, and leaves.--Fennah (179); St. Lucia Department of Agriculture (518).

Listroderes obliquus Klug, the vegetable weevil

A vegetable weevil, probably this species, attacks carrots in New Zealand. Derris as a dust or spray will be an efficient destroying agent.--Pritchard (476).

Listronotus oregonensis (Lec.), the carrot weevil

Listronotus latiusculus (authors, not Boh.)

Derris and pyrethrum were tried against this pest on celery in New Jersey but they were not promising.--Pepper and Hagmann (461).

Pantomorus godmani (Crotch), the Fuller rose beetle

A derris-talc dust containing 0.75 percent of rotenone killed only 26 percent of the weevils on a field of kale near Norfolk, Va.--Walker and Anderson (644).

Rhynchites auratus Scop.

Rhynchites aequatus (L.), an apple fruit weevil

Repeated applications of dust or liquid preparations of derris-pyrethrum were suitable in dry weather.--Thiem (586).

Rhynchites germanicus Hbst., a strawberry stem borer

Outbreaks of this weevil on strawberry in England can be checked by a prompt application of a derris dust, but where an infestation is severe a second application may be necessary.--Massee (399).

Several proprietary dusts of derris were more effective in Germany than mixtures of derris and pyrethrum. In laboratory tests the percentage of mortalities given by dusts containing derris, nicotine, and pyrethrum were respectively 100, 60, and 0.--Jancke (314).

Derris and derris-pyrethrum preparations applied as dusts gave best results in the upper Rhine district.--Hanf (257).



In Germany 430 acres of strawberry plants were severely attacked in 1941 by R. germanicus and Anthonomus rubi. These weevils were best controlled by dusting with derris, or a mixture of derris and pyrethrum, at the rate of 27 pounds per acre.--Reimann (501).

Sitophilus oryza (L.), the rice weevil

In South Australia derris was ineffective.--Andrewartha (19).

In India stored grain was ineffectively protected by mixing pyrethrum or derris with it.--Anonymous (4).

Sternechus paludatus (Casey), a beanstalk weevil

In New Mexico a commercial cube dust and derris dusts containing 3 and 5 percent of rotenone, respectively, used as contact insecticides, were not effective.--Shaw and Douglass (536).

#### Dermestidae

Attagenus piceus (Oliv.), the black carpet beetle

Woolen fabric treated with derris resin was eaten only slightly by the larvae.--Heal (275).

#### Elateridae

Agriotes spp.

In tests on the control of wireworms on lettuce in England, derris and Lonchocarpus failed to give protection against the larvae.--Speyer and Parr (559).

#### Meloidae

Epicauta vittata (F), the striped blister beetle

A dust containing 2 percent of rotenone, made by combining equal parts of talc and derris (4 percent of rotenone) was effective in destroying the striped blister beetle on garden crops in Arkansas.--Horsfall (289, 290).

Unidentified or other blister beetles

Rotenone is the standard insecticide for blister beetles. Nicotine is ineffective.--U. S. Bureau of Entomology and Plant Quarantine (628).

Rotenone and copper-rotenone were considered poor for blister beetles in victory gardens in Indiana.--Reed (496).

A talc-rotenone dust containing 2 percent of rotenone was tried against 7 species of blister beetles in Arkansas.--Horsfall (290).

#### Nitidulidae

Meligethes aeneus (F.), a rape beetle

In England two applications of derris dust failed to protect seed crops of swedes and kale, and four applications increased the crop only slightly. In tests under insectary conditions, mortality caused by derris after 6 days was 85.0, 62.5, and 82.5 percent. The general effect was that of a repellent.--Jary and Austin (320).

Derris dusts were effective and some were inexpensive against rape in Germany. In dry weather their toxic effect continues for 3 days but a 0.2 inch of rain washes off the dust. In one test, 10 applications of Kumex (0.8 percent of rotenone) were necessary owing to bad weather but even so, the measure was profitable.--Blumek and Meyer (59).

In Germany the best results were given by Kumex which gave complete mortality in 24 hours in the laboratory, and reduced the infestation on rape in the field by 90 to 95 percent in the same period. In one field the dust was still effective 5 days after application.--Frey (200).

In view of the good results given by Kumex, this material and another proprietary derris dust (L) with the same rotenone content were applied in East Holstein. Kumex was satisfactory when applied to 200 acres of rape at the rate of 22.5 pounds per acre. Infestation was decreased by 90 percent 1 day after treatment. Kumex always gave good results, but the other derris dust was completely inefficient.--Goffart and coworkers (234).

Kumex is widely used in Germany for control of the rape beetle, but it is not usually applied after the plants begin to bloom for fear of poisoning honeybees. Experiments were therefore carried out to test the necessity for this precaution. The dust was applied at unusually high rates and the bees suffered no harmful effect.--Kaufmann (336).

An attempt was made to find a substitute for Kumex which had been found effective against the rape beetle in Germany. In the laboratory Kumex gave 100 percent mortality in 2 days when undi-

luted, and 100 and 92 percent in 4 days when diluted with talc at the rates of 1:1 and 1:3, respectively. In infested rape fields, the percentage mortalities given by 2 applications were 81 and 80.5 for undiluted Kumex, 88.5 and 92 for another derris dust, and 76 and 66 for a dust of derris and nicotine. In laboratory and field tests of four synthetic stomach poisons, none were as effective as Kumex.--Meyer (413).

#### Ostomidae

Tenebroides mauritanicus (L.), the cadelle

The larvae were the most efficient in penetrating packages of foodstuffs, but when the packages were impregnated with 3 percent of rotenone, penetration was prevented for 27 days.--Essig and coworkers (169).

#### Scarabaeidae

Phyllopertha horticola (L.) (= Anomala (P.) H. L.), a cockchafer

The adults seriously injured the leaves and fruits in orchards in the Lower Elbe district, Germany. In laboratory tests, pyrethrum did not give satisfactory control but derris sprays were fully effective.--Speyer (560).

Macroductylus subspinosus (F.), the rose chafer

Peach trees in a Connecticut orchard, where the young fruits were being attacked by large numbers of this pest, were treated with sprays containing lead arsenate, or 10 pounds of cube powder with skim milk spreader in 100 gallons of water. A week later there were no adults on the 50 trees treated with lead arsenate, 8 on 22 trees treated with cube, and 70 on 50 unsprayed trees. In a private garden only partial control was given by 2 pounds of cube and 1 pound of pyrethrum in 100 gallons of water.--Garman (219).

Popillia japonica Newm., the Japanese beetle

One of the four most useful sprays tested contained derris.--U. S. Bureau of Entomology and Plant Quarantine (615).

Derris is an effective repellent for this beetle.--Chisholm and Goodhue (113).

Tests of the protective value of seven sprays were made on apple and shade trees in Maryland in 1939. A spray consisting of 10 pounds of derris (1 percent of rotenone), 3 pounds of rosin

residue emulsion, and 100 gallons of water, was sixth in value. In 1941, 18 spray mixtures were tested. Lead arsenate with an appropriate sticker was the best spray material used. Derris or rotenone dust with a good sticker was the most efficient of the non-poisonous materials tested.--Langford and coworkers (353, 354).

A spray of 6 pounds of ground derris root (4 percent of rotenone) and 1 quart of rosin residue emulsion per 100 gallons of water gave protection to ornamental trees and shrubs in Connecticut, provided the plants were treated every 5 or 6 days.--Johnson (329).

Lead arsenate gave better control of the Japanese beetle and retained its effectiveness longer than did rotenone.--McKenna and Hartzell (384).

Derris, mixed with soil in which beetle larvae were confined in earthen pots, was so slightly toxic as to be of little practical value. The slight insecticidal value of derris was destroyed by adding lime to the soil.--Fleming (188).

To control the adult beetles the use of various sprays, including lead arsenate and rotenone-bearing materials, is recommended.--U. S. Bureau of Entomology and Plant Quarantine (625, p. 769).

Derris powder (4 percent of rotenone) with a spreader-sticker, sprayed on elms and other plants, afforded temporary relief from intensive Japanese beetle feeding, but bordeaux mixture with lead arsenate was the best of several sprays used.--Collins and Nardy (117).

Dusts and sprays containing derris or cube powder and their active principles are repellent to the Japanese beetle.--Hamilton (253, p. 11).

One of the more important uses of rotenone is to control the Japanese beetle.--Howard and coworkers (294, p. 31).

Rotenone is effective, but nicotine is ineffective against this fruit pest.--McIndoo (383).

Rotenone was recommended against this beetle on many plants in victory gardens.--White and Doolittle (683, p. 22).

For use against the Japanese beetle the substitute for rotenone is lead arsenate.--U. S. Department of Agriculture (633, p. 14).



Silphidae

Silpha (Blithophaga) opaca L.

Kumex (a proprietary product containing rotenone) was a quick and effective means of control of the larvae on beets in Germany.--Kaufmann (335).

HOMOPTERA

Aleyrodidae

Dialeurodes citri (Ashm.), the citrus whitefly

Derris is toxic to the larvae.--English (165).

Aphidae

Amuraphis roseus Baker, the rosy apple aphid

Satisfactory control resulted when cube was used in oil in delayed dormant spray.---Steiner and Worthley (567).

When cube was combined with 1 pint of manniten monolaurate, fair control was obtained. An effective and economical combination includes 3 pounds of cube in a 3-percent Goulac stock emulsion or tank-mixture.--Steiner (565).

Aphis gossypii Glov., the cotton aphid, melon aphid

On the basis of the medial lethal dose, cube-talc dust (0.25 percent of rotenone) was significantly more toxic to this aphid on okra in laboratory tests when combined with 1 percent of grapefruit-seed oil or soybean oil than when used alone. Likewise, the addition of 1 percent of peanut or olive oil increased the effectiveness of the dust, but the differences were not significant.--Howard and Apple (293).

The cotton aphid and boll weevil infestations were lowest on plots treated with calcium arsenate plus 1 percent of nicotine. Dusts containing 1 percent of rotenone gave excellent aphid control in 1941, but failed to control aphids in 1940. Yields of seed cotton per acre treated with calcium arsenate, 10 percent of sulfur, and  $\frac{1}{2}$  percent of rotenone were 1,384 pounds; with calcium arsenate alone, 1,258 pounds; with calcium arsenate and 1 percent of nicotine, 1,674 pounds; and with calcium arsenate, 10 percent of sulfur, and 2 percent of pyrethrins, 1,368 pounds. The untreated check yielded 1,269 pounds.--Beenel and Floyd (45); Floyd and coworkers (189, 190).

Serious cotton-aphid infestation in Peru can be prevented by dusting with a mixture containing cube (0.75 to 1.5 percent of rotenone) and finely ground dusting sulfur.--Bibby (50).

A dust containing equal parts of tobacco dust and sulfur with enough derris or cube added to give a 1-percent rotenone content gave satisfactory control if the plants were wet at the time of application. The addition of  $\frac{1}{2}$  percent of rotenone to cryolite and barium fluosilicate reduced aphids by 88 and 76 percent, respectively, as compared with the calcium arsenate plots. Derris, cube, or nicotine sulfate, added to calcium arsenate dusts, in all cases prevented the development of damaging aphid infestation. Rotenone was superior to nicotine. Experiments in which 0.5 percent of rotenone was added to calcium arsenate were conducted at seven locations in six states. The data showed that this mixture was effective in keeping the aphid population at or below that in untreated check plots and caused a significant increase in yield over plots treated with calcium arsenate alone. Derris, cube, and timbo were equally effective as sources of rotenone. There were highly significant differences in aphid control favoring the insecticides which contained derris over those which did not.--Bondy and Rainwater (65-67); Rainwater (489); Rainwater and Bondy (491).

Following eight effective dust applications, there were 3.6 times as many aphids on cotton dusted with calcium arsenate plus 0.5 percent of rotenone as on cotton treated with calcium arsenate plus 1 percent of nicotine.--Ewing and Moreland (173, 174).

Calcium arsenate-rotenone prevented aphid increases better than calcium-zinc arsenate, but for yields the two mixtures were equally effective and better than calcium arsenate alone. In 1934 and 1935 derris used alone or with sulfur seemed not to have increased the yield of cotton. In 1940-1942, however, when cube, derris, rotenone, or timbo was combined with calcium arsenate, or with arsenate and sulfur, the increase in yield was usually considerably over that for calcium arsenate, or arsenate plus sulfur. The special mixture of calcium arsenate, sulfur, and rotenone significantly controlled cotton aphids and increased the yield of cotton at Tallulah.--Gaines (210, 212); Gaines and Dean (211).

Before the war good results had been obtained in controlling the cotton aphid by the addition of derris or cube to calcium arsenate, used for boll weevil control. The mixture contained 0.5 percent of rotenone which was recommended for 1 year when war restrictions prohibited its use on cotton.--[Harned] (266).

Calcium arsenate-sulfur mixtures, with derris added, effectively controlled the cotton aphid and boll weevil. Treatments of calcium arsenate plus nicotine, the arsenate-sulfur mixture plus nicotine, and Lethane 60, all gave significantly better aphid control than calcium arsenate plus 0.5 percent of rotenone.--McGarr (381); McGarr and Henry (382).

Serious infestations of the cotton aphid may be prevented by using a mixture of calcium arsenate and derris or cube so that the finished product contains 0.5 percent of rotenone.--Little and Martin (368, p. 108).

Dusts made by mixing 20 pounds of derris or cube (5 percent of rotenone) with 80 pounds of calcium arsenate have been used on cotton plants to prevent the increase of aphids that often follows dusting with calcium arsenate. Since commercial calcium arsenate may contain up to 10 percent of free hydrated lime, and since the insecticidal value of the derris or cube is destroyed in an alkaline environment, such mixtures should not be used after they have stood several months. It is estimated that 50,000 pounds of derris and cube were used in 1941 for dusting cotton.--Roark (505).

The effect of insecticidal drift in small plots was tested upon the cotton aphid. The number of aphids found in each plot after the treatments started averaged 12.5 per square inch in the four check plots, 22.7 in the two plots dusted with standard calcium arsenate, 7.6 in the two plots dusted with a mixture of this arsenate and derris, and 25.8 in two plots dusted with a special calcium arsenate.--Smith and coworkers (551).

Calcium arsenate and derris, cube, or timbo mixtures were equally effective against the cotton aphid, and gave highly significant decreases in aphid infestation and increases in yield when compared with calcium arsenate alone. Mixtures of calcium arsenate and nicotine gave better aphid control and a greater yield than a mixture of the arsenate and rotenone. Late-afternoon applications of calcium arsenate and cube containing 0.5 percent of rotenone were more effective against aphids, and were followed by a slightly higher yield than early-morning applications, but the difference in yield, however, was too small for significance.--Young and coworkers (707-709).

Aphis maidis Fitch, the corn leaf aphid

This species is an insect vector of mosaic of sugar cane. Dust insecticides reduced the spread of mosaic in seed cane in some, but not in all experiments. Significant decreases were given by derris and pyrethrum but not by nicotine sulfate.--Ingram and coworkers (310).



This insect on sugar cane in the Philippine Islands can be controlled with derris powder.--Otanés and Karganilla (453).

Aphis pomi Deg., the apple aphid

A laboratory-prepared sample of pure rotenone gave 100 percent mortality at a concentration of 3 ounces in 100 gallons of water with a wetter, and an approximately complete kill at 2 ounces with sodium cleate. Nicotine and anabasine sulfates with accessory agents gave almost complete mortalities down to concentrations of 1:3,200.--Yothers and Griffin (706).

NNOR, (technical manritan monolaurate, 97.2 to 96.4 percent, rotenone 1 percent, and other derris extractives 1.8 to 2.6 percent) at 1:800 gave excellent control.--Roth and Pyenson (517).

Acetone extracts of the roots of the Texas Tephrosia virginiana, grown in New Jersey, were highly toxic to this aphid.--Ginsburg and coworkers (227).

Aphis rhamni Boyer de Fonscolombe

Derris resin tested in England against the eggs of this aphid was more toxic, weight for weight, than 4,6-dinitro-o-cresol which is recognized as one of the most potent oviocides.--Potter and Tattersfield (471).

Aphis fabae Scop. (=rumicis L.), the bean aphid

Potassium oleate soap was definitely a better spreader for derris than either potassium soap of FF wood rosin or that of rosin residue. When used alone the order of effectiveness (from most effective to least effective) for the three toxic agents under test was as follows: Acetone extract of derris, Black Leaf 40, and 20 to 1 alcoholic extract of pyrethrum.--Fassig and Pierpont (176).

Yam bean (1.5 g. to 100 cc. of water) killed 99 percent, while cube ( $\frac{1}{2}$  g. to 100) killed 100 percent of the aphids. Water suspension of ground yam beans and various extracts of them each killed 100 percent, or nearly so, of the aphids tested, while water suspension of cube powder and various extracts of it each killed 100 percent. Also, the water suspensions of the powdered root and seed of Millettia pachycarpa killed 100 percent of the aphids, but the various extracts of the seed were not so generally effective.--Hansberry and Lee (258); Lee and Hansberry (360).



The most interesting fish-poison plant from an insecticidal viewpoint was a vine from the British Solomon Islands, which was indistinguishable from Derris trifoliata. Its leaves were somewhat more toxic than the roots to the bean aphid, but they were less toxic than the roots of D. elliptica.--Tattersfield and co-workers (582).

Samples of Mundulea serica from Union of South Africa contained no rotenone, but tests with the bean aphid showed that the roots have definite insecticidal action though not sufficient to be of much economic value. Samples of leaves of Tephrosia vogelii from Uganda gave positive biological tests, having paralyzed 100 percent of the aphids.--Imperial Institute of London (308).

Aphis spireacola Patch, the spirea aphid

Potassium oleate soap was a better spreader for derris than potassium soap of FF wood resin.--Fassig and Pierpont (176).

Aphis tavaresi Del G., an orange aphid

Suspension of ground root of Derris elliptica, cultivated in Mauritius, successfully controlled this aphid on citrus when applied at the rate of 5 pounds to 100 gallons of water.--Jepson (323).

Brevicoryne brassicae (L.), the cabbage aphid

A dust containing derris, sulfur, hydrated lime, and nicotine sulfate (25:37.5:37.5:5) by weight was much more effective than one of derris and talc with the same rotenone content, but little or no more effective than one of derris, talc and nicotine sulfate (25: 75:5) in a field experiment. Derris and Tephrosia were more effective than Lonchocarpus of the same guaranteed rotenone content.--Arant (22, 23, 26).

A derris-nicotine dust, with sulfur and hydrated lime as diluents, was approximately as effective as a lime-nicotine sulfate dust. A common derris dust appeared to be ineffective in controlling the cabbage aphid. In 3-year trials it was possible to control both cabbage worms and aphids with a single dust containing free nicotine 2.5 percent, dusting sulfur 20 percent, derris (5 percent of rotenone) 15 percent, and talc or hydrated lime 62.5 percent.--Brooks and Allen (91); [Allen] (15); Wisconsin Agricultural Experiment Station (696, p. 65).

Acetone extracts of the roots of the Texas Tephrosia virginiana were highly toxic to this aphid.--Ginsburg and coworkers (227).

The control of aphids on cabbage includes the use of derris and cube with summer oil, and pyrethrum and rotenone sprays and dusts.--Hutson (303).

The standard recommendations in New York include a dust containing 0.75 to 1 percent of rotenone, or a spray containing 4 pounds of derris or cube powder (4 to 5 percent of rotenone).--Parrott (457).

In Crimea the toxicity of the introduced species of Tephrosia was greater when they were dispersed in mineral oils. Extracts obtained by the hot method were more effective than those by cold extraction.--Blyumberg (60).

In Russia various extracts of Tephrosia were tested against the cabbage aphid. Extracts obtained with chloroform, carbon tetrachloride, trichloroethylene, and ethylene dichloride were more toxic than those obtained with benzene and benzine. Ethyl alcohol and methyl alcohol extracts were the least effective. The toxicity of the extracts increased when they were redissolved in kerosene or transformer oil. When chloroform extracts of T. candida were dissolved in acetone, the percentages of mortality were 6.6, 9.6, and 81.2 for the leaves, roots, and stems, respectively, and these results were superior to those given by T. species and T. vogelii.--Bogatova (61).

Capitophorus braggii Gill.

A cube dust (1 percent of rotenone) with Vatsol-OS (1 percent) and a spray of 4 pounds of cube powder (4 percent of rotenone) with 1 gallon of light-medium oil emulsion and 100 gallons of water gave good control of this aphid on artichoke in California.--Lange (351).

Eriosoma lanigerum (Hausm.), the woolly apple aphid

Sprays of white oil and derris used against a red spider in England caused attacks by the woolly aphid to be less severe than usual.--Hey (286).

Cream of Agicide (a rotenone-bearing compound) 1:200, 1 quart per tree, gave poor control of the root form of the woolly aphid.--Smith (549).

Pure rotenone was ineffective at concentrations as high as 8 ounces in 100 gallons of water even when used with wetters. When the same concentration was used with 4 pounds of soap, a kill of only 93.5 percent of the aphids was obtained.--Yothers and Griffin (706).

Macrosiphoniella sanborni (Gill.), the chrysanthemum aphid

None of the four species of Annona tested in the laboratory in England are superior to the leaf, root, and bark of Mundulea serica, and all were much less toxic than the richer specimens of Derris elliptica root.--Tattersfield and Potter (583).

Three toxicity tests of mixtures of rotenone with deguelin concentrate, elliptone, and 1-alpha-toxicarol, respectively, were examined statistically. In each case, an hypothesis of independent action of the constituents would underestimate the toxicity of the mixture, but similar action satisfactorily predicts the observed percentage of kill.--Finney (185).

1-Elliptone was one-fifth as toxic as rotenone to this aphid when tested in an alcohol-saponin medium. When the observed toxicities of mixtures of rotenone with a deguelin concentrate, 1-elliptone, and 1-alpha-toxicarol were compared with those predicted from the potencies of the constituent poisons, no significant synergistic or antagonistic effect was found, and it is therefore considered that the use of the rotenone-equivalent method for assessing the toxicities of derris roots or resins is justified.--Martin (397).

Macrosiphum pisi (Kalt.), the pea aphid

This aphid in Wisconsin was effectively controlled by dusting thoroughly with a 1-percent rotenone dust at the rate of 25 to 30 pounds per acre, but under warm, wet conditions as little as 20 pounds was effective.--Delwicke and coworkers (138); Wisconsin Agricultural Experiment Station (692).

In Quebec the use of a bamboo pole drag enhanced the value of rotenone dust.--Maltais (389).

The addition of a small amount of crude peanut oil to a derris dust mixture appreciably increased the effectiveness of the dust.--Bronson and Dudley (90).

A derris-nicotine dust with sulfur and hydrated lime gave fair results.--Brooks and Allen (91).

Comparative results, obtained by applying dusts and sprays of derris and cube including Black Arrow 88 (4.6 percent of rotenone), Black Arrow 77 (3.7 percent of rotenone), and Black Arrow 444 (1.05 percent of rotenone), showed that derris appeared to be superior to ordinary cube in effectiveness. Good kill obtained with micronized cube indicated that fine grinding might increase the toxicity. Dusts appeared to be slightly better than sprays. Dusts applied at high humidity when the dew was on the plants gave slightly better results than dusts applied later in the day when the temperature was higher, humidity lower, and plants dry.--Ditman and coworkers (145).

Rotenone dusts were slightly erratic in their effect but normally gave satisfactory control.--Glasgow (228).

A rotenone-talc dust containing 4 percent of vegetable or animal oil appeared to have possibilities in Oregon. Rotenone dust with a wetting agent did not give as good control as did rotenone and oil. Nicotine-lime dust and pyrethrum-talc dust were inferior to the rotenone-oil dusts. Loro-talc-rotenone dusts gave good kills but produced a slight burning.--Gray and Schuh (241).

The determination that derris and cube powders could be used to control the pea aphid is one of the high lights of the last 5 years. An industry which meant a great deal to the prosperity of the Pacific Northwest was relieved of a production hazard which threatened marked curtailment, if not abandonment.--Rohwer (513, p. 61).

Vaporized nicotine gave higher initial kill than did derris-talc dusts but the latter had more residual effect. Derris-talc dusts plus Vatsol OS were more effective than a similar dust without a wetting agent. An atomized oil containing rotenone or nicotine gave high kills of the pea aphid, but owing to poor coverage failed to give entirely satisfactory results near Norfolk, Va.--Walker and Anderson (643).

In Maryland derris was superior to cube, and derris dusts were superior to derris sprays. Moisture on the plants at time of application of derris dusts was more important to the success of the treatment than high temperature. Fine grinding increased the effectiveness of both cube and derris. The nicotine vaporizer gave the highest kill of all the treatments used.--Ditman and coworkers (146).



In Oregon use was made of a power duster that was attached to the front of a motor car and provided with a new type of hood to prevent the escape of the aphids. A 0.75-percent rotenone dust plus 3 percent soybean oil, applied at 35 pounds per acre, was the most effective. This dust can also be used to control aphids on trellis peas. Based on 4 years' investigations a spray that can be recommended for trellis peas contains 1.66 pounds of cube, derris, or timbo (4 percent of rotenone), 100 gallons of water and a wetting agent.—Gray and Schuh (242).

An acetone extract of derris, used as a spray, was the most effective insecticide used against the pea aphid in Maine.—Hawkins (272).

With adequate equipment and proper insecticides the pea aphid can be controlled, and serious commercial losses prevented. Derris or cube dusts (not less than 1 percent of rotenone) applied at the rate of 35 to 40 pounds per acre were recommended in Utah.—Knowlton (342).

Nicotine applied by a vaporizer gave excellent control and was more widely used commercially in 1940 than any other treatment in Virginia. Derris or cube dusts with talc gave variable results. The duster boom should be completely enclosed and a 25-foot trailer should be attached. Derris sprays with a suitable wetting agent gave adequate control of aphids.—Walker and Anderson (646).

Pyrophyllite (Pyrax ABB), flaky talcs, calcium carbonate, and gypsum produced high electrostatic charges which were reduced with the addition of rotenone, but when oil was added to the mixture the charge was greater than that produced by the diluent alone. Pyrophyllite produced the highest charge while ground cube and derris roots produced a charge opposite to that of the diluents. The percentage of kill usually increased in proportion to a general increase in the electrostatic charge produced by a mixed dust. These charges develop best on warm, dry days and this may explain in part why rotenone dusts give the best kill of pea aphids when applied in warm weather.—Wilson and coworkers (688); Wisconsin Agricultural Experiment Station (693, p. 48).

Dust mixtures containing nicotine were recommended as a substitute for rotenone in combating the pea aphid, although rotenone is more effective. The recommendation, issued February 1942, specified (1) the use of a 1-percent rotenone dust applied at the rate of 35 to 40 pounds per acre, or (2) the use of a 4-percent nicotine dust applied at the same rate. The revised recommendation for the emergency

was (1) to use a 0.75-percent rotenone dust, applied early and thoroughly at the same rate with the aid of a boom on the duster enclosed completely and with a 25-foot trailer, and (2) to use a 4-percent nicotine dust whenever possible.--U. S. Bureau of Entomology and Plant Quarantine (626).

When SAE 10 lubricating oil and certain adjuvants were added to rotenone dusts, consistent increased control with low concentrations of rotenone was obtained. In one field test with four replicated plots, a dust mixture containing 0.1 percent of rotenone, 2 percent of this oil, and 2 percent of propylene laurate showed a control of 90 percent in 24 hours.--Campau and coworkers (101).

Early application of rotenone dusts effectively controlled the pea aphid in Wisconsin.--Carroll (103).

Rotenone dust and spray was considerably less effective than nicotine applied as a spray or by a vapofumer in a 20-acre field of peas in New York. For a 5-year period the population was reduced 94 percent by a concentrated spray of free nicotine and 2.5 percent of rotenone, 92.7 by free nicotine vaporized, 86.5 by a concentrated spray of nicotine sulfate, 79.8 by a 2.5 percent rotenone spray, and 79.3 by a 1-percent rotenone dust with 2 percent soybean oil and pyrophyllite.--Glasgow (230, 231).

One or two applications of a 1-percent rotenone dust or a spray containing 4 pounds of derris (4 to 5 percent of rotenone) in 100 gallons of water with a spreader, made 2 to 4 weeks before pea harvest, often resulted in increased yield of peas.--Huckett (298).

Good commercial control is possible with dusts containing as little as 0.5 percent of rotenone when the temperature is as low as 60°F., and with a machine and a properly weighted apron satisfactory control can be secured at wind velocities up to 15 miles per hour.--Janes and Wilson (318).

Certain combination dusts containing reduced concentrations of rotenone and free nicotine gave consistently good control of the pea aphid in the field for 2 years.--Lilly (363).

In California 1,614 acres were dusted with rotenone compounds by using the airplane.--Mackie (385, p. 351).

Rotenone dusting, although occasionally ineffective in New York, is considerably cheaper than either nicotine vaporfuming or nicotine dusting.--Parrott (457).

A 0.6-percent rotenone dust with 3 percent of Lethane 384 and a 0.4-percent rotenone dust with 2 percent of Lethane gave promising results near Norfolk, Va.--Walker and Anderson (647).

Many factors contribute to the effectiveness of rotenone, three of which include the diluent selected, the equipment used in applying dusts, and the care employed when dusting. As a class, talcs appear to be the best diluents although none of them equalled Pyrax. Adding 2 percent of lubricating oil increases the electrostatic charge of talcs but reduces the charge of some materials. When 22 samples of talc and 3 of pyrophyllite were examined only 5 of the former and 1 of the latter were compatible with rotenone. The failure in the past to secure consistent control of insects with derris and cube dusts was mainly due to the use of unsuitable diluents and methods of application. When a compatible diluent was used as a carrier and oil was added the dust was highly toxic to the pea aphid. With compatible diluents and optimum application methods significant reductions in rotenone content can safely be made with no loss in kill. A 1- or 0.75-percent rotenone content in these diluents are not significantly better than 0.5- or 0.25-percent rotenone dusts. Pyrophyllite was better than clay as a diluent for cube dust. All dusts with a rotenone content of 0.5 to 1 percent to be used for control of the pea aphid should be conditioned with 1 or 2 percent of oil, such as soybean oil.--Wisconsin Agricultural Experiment Station (696, p. 53); Wilson and Bender (685); Wilson and Janes (689-691).

In 1943 it was concluded that 5 years' work in Maryland with derris sprays had provided a satisfactory monetary return. A 1-percent rotenone dust gave as good results as a derris spray but cube sprays did not give adequate control. The effectiveness of rotenone insecticides varied from year to year. There was a strong relationship between toxic action of the rotenone and adequate rainfall both preceding and following the treatments. Nicotine sprays were better than derris sprays, and the nicotine vapor-fumer gave the highest kill.--Ditman and coworkers (144).

The most satisfactory treatment for the pea aphid on peas in Wisconsin was the use of a dust containing at least 0.5 percent of rotenone mixed with pyrophyllite or talc, applied at the rate of 35 to 40 pounds per acre. Directions were given for increasing the effectiveness of this mixture by adding nicotine or light lubricating oil. Derris or cube sprays containing 3 pounds of powder, 4 to 8 ounces of a suitable wetting agent, in 100 gallons of water were also effective when applied at the rate of 125 gallons per acre under a pressure of at least 300 pounds.--Dudley and Bronson (149).



One of the more important uses of rotenone is to control the pea aphid.--Howard and coworkers (294, p.31).

Mixtures of pyrophyllite, cube powder, and Black Leaf Dust Base exhibited a true synergistic relationship between the two toxicants. Most of the blends gave superior pea aphid control in extensive field tests. About 10 percent of dusting sulfur should be added to the combination to reduce nicotine loss if the dusts are to be stored before use. Similar combinations with the addition of an aliphatic thiocyanate were also effective and showed still greater economy of rotenone-bearing materials and nicotine.--Lilly (364).

Suggestions for pea aphid control were published by the Eastern Pea Aphid Conference in March 1943. Among the methods suggested were the following: (1) Use 3 pounds of derris or cube powder (4 percent of rotenone) and 4 to 8 ounces of a wetting agent per 100 gallons of water, applied at 125 gallons per acre; (2) Use a 0.5-percent rotenone dust mixture containing pyrophyllite or talc and 1 percent of mineral oil, applied at 35 to 40 pounds per acre under a 25-foot apron; (3) Use a dust mixture containing 0.5 percent of rotenone, 2 percent of nicotine, and 10 to 25 percent of sulfur diluted with pyrophyllite or talc; and (4) use a 0.5-percent rotenone dust mixture to which is added 2 percent of Lethane 60.--Pepper and coworkers (460).

The American Association of Economic Entomologists, at its 1941 annual meeting, appointed a special committee on the insecticide supply situation, J. L. Horsfall, chairman. The committee reported that since rotenone materials were limited in 1943 one approach to the problem would be the use of mixtures of rotenone with thiocyanates or nicotine added.--Horsfall and coworkers (288).

A dust mixture containing 0.375 percent of rotenone, 1.7 percent of nicotine, and 10 percent of sulfur was as useful as a mixture containing 0.75 percent of rotenone.--U. S. Bureau of Entomology and Plant Quarantine (628).

Black Leaf 10 dusts containing 2 or 3 percent of nicotine in combination with 0.25 or 0.5 percent of rotenone gave about the same initial kill but had more residual effect than the 4-percent nicotine dusts. Cube-pyrophyllite dusts containing 0.75 or 1 percent of rotenone were significantly better than those containing 0.2 or 0.4 percent of rotenone. A 0.2- or 0.4-percent rotenone dust plus 3 percent of Lethane 60 was as effective in controlling the pea aphid as any of the other dusts tested in Virginia.--Walker and Anderson (649).



Tests in Wisconsin indicated that dust mixtures containing 0.1 to 0.25 percent of rotenone, and 2 percent of Lethane 60 or 1 to 2 percent of Loro were comparable with dust mixtures containing 0.75 percent of rotenone and 1 percent of SAE 10 lubricating oil. Oil added to rotenone dusts, when stored for some time, may cause a reduction in toxicity, but such dusts can be reconditioned with the addition of 1 percent of oil. A summary of greenhouse tests with rotenone dusts showed that the aphid control was significantly improved by increasing the oil content of the dust mixture from 2 percent to 4 percent.--Wilson and Campau (686, 687).

A rotenone-nicotine blend recommended for the pea aphid contains: Rotenone 0.375 percent, nicotine alkaloid 1.7 percent, sulfur 10 percent, hygroscopic agent 1 to 2 percent, and the remainder pyrophyllite or a satisfactory talc. Both field and laboratory trials showed that 0.5 percent of rotenone will give almost as good control as the 0.75-percent product which formerly was the standard, when both are used with oil and a suitable diluent.--Wisconsin Agricultural Experiment Station (697, p. 47).

Macrosiphum solanifolii (Ashm.), the potato aphid

Rotenone is more effective than nicotine against this aphid on potatoes. It was recommended in February 1942 that a 0.75-percent rotenone dust be substituted for the 1-percent rotenone dust formerly used.--U. S. Bureau of Entomology and Plant Quarantine (626).

The general use of pyrethrum-sulfur or rotenone-sulfur combinations on potatoes may be limited by their failure to prevent late blight and by their higher costs.--Daines and coworkers (134).

Cube dusts (0.75 percent of rotenone) were effective, but pyrethrum dust gave erratic results and were definitely less efficient. The use of pyrethrum and rotenone dusts instead of bordeaux mixture for control of potato insect pests has been recommended because bordeaux, in many years, has decreased yields.--Rawlins and coworkers (493).

Myzus persicae (Sulz.), the green peach aphid, spinach aphid, or tobacco aphid

Calcium arsenate undiluted was used alone and in combination with derris (0.5 percent of rotenone in mixture). The derris had some effect in retarding aphid increase on peppers in California, but not enough to prevent serious aphid infestations.--Elmore and Campbell (163).

In tests with this aphid on turnips the medium lethal dose of cube-talc dust appeared to be decreased by the addition of conditioning agents.--Howard and Apple (293).

A derris suspension containing 0.02 percent of rotenone used as a spray or dip gave good control of this aphid on tobacco in seed beds in Java. The seedlings were immersed up to the roots in bundles of 50 to 100 when they were transplanted.--Schweizer (531, p. 41; 532, p. 25).

In New South Wales this aphid on cabbage may be controlled by the use of derris dust throughout the season.--New South Wales Department of Agriculture (443).

Rotenone is more effective than nicotine for the green peach aphid on potatoes, peppers, and spinach.--U. S. Bureau of Entomology and Plant Quarantine (628).

A spray containing 0.2 percent of derris powder (10 percent of rotenone) and 0.1 percent of soap gave the best control in Sumatra and freed from infestation 97 percent of 3,510 tobacco leaves in one series, and 99 percent of 2,898 leaves in another.--Laan (349).

In preliminary tests in Virginia a derris-Lethane 384 dust was not effective in controlling the spinach aphid. Black Leaf 155 was not so effective as derris dust in controlling larvae of the diamond-back moth but was more effective in controlling Myzus persicae on collards. A combination of the nicotine and derris tended to be more effective than the nicotine alone in controlling the aphids, and more effective than the derris alone in controlling the larvae of the moth. Also the hydrated lime tended to be a better diluent for the derris-Black Leaf 155 mixture than pyrophyllite when used within 8 days after being mixed. Derris-pyrethrum dust gave good control of the moth, but did not give satisfactory control of the aphids. Several growers used Black Leaf 10-derris dusts and Black Leaf 155-derris dusts for the control of aphids and the larvae of the diamondback moth on their kale and collards with very satisfactory results.--Walker and Anderson (647, 650).

(Myzus) Capitophorus rosarum (Kalt.)

Acetone extracts of the roots of Tephrosia virginiana from Texas were highly toxic to this aphid.--Ginsburg and coworkers (227).

Pemphigus sp., a poinsettia root aphid

Cube powder did not kill more than half of those treated. The

earth balls were bumped out of pots and the roots bearing the aphids were dusted.--Bieberdorf and Fenton (51).

Phorodon humuli (Schr.), the hop aphid

In Bavaria it was recommended that nicotine be used until blossom time of hops, and derris alone or with pyrethrum from then onward.--Hampp and Jehl (256).

In England some hop growers prefer to use a derris preparation instead of nicotine.--Masse (402).

Rhopalosiphum pseudobrassicae (Davis), the turnip aphid

Under field conditions a derris mixture containing 1 percent of rotenone with equal parts of finely ground tobacco dust and "300-mesh" dusting sulfur as a diluent proved superior to a dust mixture containing 3 percent of nicotine. Good results were obtained with a spray containing 2 pounds of finely ground derris or cube root (4 to 5 percent of rotenone) per 50 gallons of water, at the rate of 100 to 125 gallons per acre, at intervals of 7 to 14 days.--Allen and Harrison (11); Harrison and Allen (267).

Pyrethrum and 1-percent nicotine dusts were more rapid in their action than 0.2-percent rotenone-talc dusts, but derris and cube were as effective at the end of 30 hours as were pyrethrum and nicotine. Timbo appeared less effective. Derris and Tephrosia were more effective than Lonchocarpus of the same guaranteed rotenone content.--Arant (22, 26).

It was recommended that dust mixtures containing nicotine be substituted for rotenone in combating the turnip aphid, although rotenone was preferred for this aphid on turnips. The revised recommendation for the war emergency was (1) the use of a 0.75-percent rotenone dust, applied early and thoroughly at the rate of 35 to 40 pounds per acre, and (2) whenever possible substitute a 3-percent nicotine dust for the rotenone dust.--U. S. Bureau of Entomology and Plant Quarantine (626).

Rotenone was recommended for aphids on turnips in victory gardens.--White and Doolittle (683).

Rhopalosiphum rufomaculata (Wils.)

Acetone extracts of the roots of Tephrosia virginiana from Texas were highly toxic to this aphid.--Ginsburg and coworkers (227).

Toxoptera aurantii (Fonsc.), the black citrus aphid

For the combined control of aphids, red mite, and black scale a spray consisting of light-medium oil, 0.5 to 0.75 percent, with rotenone may be used.--Quayle (482, p. 26).

Toxoptera graminum (Rond.), the green bug

Valuable seed crops in Argentina can be protected with dusts of nicotine sulfate, pyrethrum, or rotenone.--López Cristóbal (371).

Toxoptera piricola Mats.

In Japan sprays of pyrethrum, nicotine sulfate, or derris with soap, applied when the eggs on pear trees hatch in the spring, are recommended for control.--Yago and Furuichi (702).

Unidentified Aphids

Sprays containing pyrethrum or derris, or extracts from these materials, are sometimes used for the control of aphids on grapes.--Demaree and Runner (139, p. 27).

Plant sprays containing 1 percent of rotenone and 4 percent of total acetone extractives of derris root will give a good kill of many species of aphids at dilutions of 1:800.--Hamilton (253, p. 10).

A spray mixture consisting of derris powder, pyrethrum extract, and sulfonated castor oil with water is effective against aphids and many other insects.--Howard and coworkers (294, p. 31).

Derris sprays are commonly used to control aphids in China.--Chan (110).

Tests with derris and rotenone dusts as a substitute for a spray of nicotine sulfate and soft soap, for the control of aphids in Cyprus, were unsuccessful except at concentrations that were more costly than the nicotine spray.--McDonald (380).

Rotenone and copper-rotenone were considered fair for aphids in victory gardens in Indiana.--Reed (496).

For control of aphids on rape, kale, turnips, and swedes in South Africa either dusts or sprays of Pyroicide and Derrisol may be used.--Schultz (527).



A spray of 1 pound of derris or cube (4 percent of rotenone) in 25 gallons of water with a suitable spreader was effective against aphids and thrips.--Turner (596).

Work on aphids in Maine showed that aphid infestations can be greatly reduced by applications of rotenone-soybean oil and nicotine-rotenone sprays.--U. S. Bureau of Entomology and Plant Quarantine (628, p. 136).

#### Cercopidae

Clastoptera saint-cyri Prov., a cranberry spittle insect

A considerable infestation of the adults in Massachusetts was completely wiped out by dusting with 100 pounds of derris (4 percent of rotenone) per acre without an activator or wetter.--Franklin (193).

Philaenus leucophthalmus (L.) (= apumarius L.), a spittle bug on strawberry

The use of a 0.5-percent rotenone dust proved satisfactory in Washington. A 3-percent nicotine dust gave good control but was less satisfactory.--Hanson and Webster (260, p. 37).

One of the important use of rotenone is to control spittle bugs on strawberries.--Howard and coworkers (294, p. 31).

#### Chermidae

Pineus pineoides Cholodk, ( Chermes (P) p. Cholodk.)

A derris dust gave unsatisfactory control of this aphid on spruce in Switzerland.--Schneider-Orelli (523).

#### Cicadellidae

Aceratagallia sanguinolenta (Prov.), a clover leafhopper

The greatest kill obtained with derris was 52 percent at a concentration equivalent to 16 pounds of 5-percent rotenone per 100 gallons, whereas 100 percent kill with pyrethrum was obtained at a concentration equivalent to 4 pounds of ground flowers containing 0.5-percent of pyrethrins per 100 gallons.--Watkins (655).

Bythoscopus cedaranus Naude, a wattle jassid

Laboratory experiments showed that pyrethrum dust was superior to derris in the Union of South Africa.--Evans (170).

Empoasca fabae (Harr.), the potato leafhopper

In tests against the Mexican bean beetle on lima beans, the following was recommended if this leafhopper was also present: 4 pounds of derris, cube, or timbo (5 percent or rotenone) in 100 gallons of spray, or 40 pounds of dust with the addition of sulfur or a copper compound.--Huckett (299).

Derris-talc dust was not consistent in its reduction of leafhopper populations; damage was relatively high, but the yield was also high.--Manis and Leffert (390).

In laboratory tests with bordeaux mixture and aqueous suspensions of pyrethrum and derris, only the pyrethrum had an appreciable toxicity as a contact poison on adult potato leafhoppers.--Watkins (654).

Rotenone did not repel this leafhopper on citrus.--Woglum and Lewis (698).

Empoasca filamenta DeL.

A pyrethrum-cube-talc dust was effective in controlling this leafhopper on potatoes, but a cube-talc dust did not control it. The former consisted of 5 pounds of Dry Pyrocid (2 percent of pyrethrins) and 95 pounds of cube-talc dust containing 1 percent of rotenone. The latter also contained 1 percent of rotenone by weight.--Manis and Turner (391).

Empoasca maligna (Walsh), the apple leafhopper

In an orchard which had been treated yearly for 4 years with 0.5-percent rotenone dusts, leafhoppers did not develop, possibly because of the killing action of the rotenone on the adults.--Garman (222).

Empoasca Typhlocyba rosae (L.), a rose leafhopper

Dust roses with copper-rotenone dust.--McDaniel (379).

Empoasca terrae-reginae Paoli

In Queensland some control of this species on cotton was given by nicotine dusts and by two proprietary dusts containing 3.2 percent of "tubatoxins as derris," but the frequent applications that would be necessary make their use economically impracticable.--Sloan (545).

Erythroneura spp., grape leafhoppers

Sprays containing pyrethrum or derris, or their extracts, are sometimes used for control.--Demaree and Runner (139).

For control of grape leafhoppers use pyrethrum extracts in concentrated form applied in vaporized oil; rotenone extracts applied as sprays; or calcium cyanide, as dust.--U. S. Department of Agriculture (633, p. 12).

Evacanthus interruptus (L.), a hop leafhopper

Populations of this pest on hops in England were greatly reduced following two applications of a derris dust.--Massee (399).

Macrosteles divisus (Uhl.), the six-spotted leafhopper

This insect transmits the virus of eastern aster yellows to endive and lettuce. Dusting with a mixture of pyrethrum and sulfur containing at least 0.15 percent of pyrethrins, or with derris and sulfur (1 percent of rotenone) at weekly intervals from transplanting time to harvest gave significant decreases of diseased lettuce plants.--Linn (365).

Ophiola sp., the blunt-nosed leafhopper

Derris dusts (1 and 1.5 percent of rotenone) with camphor oil and peanut oil, respectively, as the activator and wetter, applied once at 95 and 100 pounds per acre, both gave at least 94 percent mortality. Results of commercial control of this jassid have indicated that treatment should be carried out thoroughly when more than 3 leafhoppers are taken by 50 sweeps of an insect net.--Franklin (193).

Typhlocyba rosae (L.), the rose leafhopper

The controls recommended in Germany against this pest on apples were a dormant spray of tar distillate, a lime-sulfur spray, or mixed dusts of derris and pyrethrum.--Voboril (640).

Unidentified leafhoppers

Rotenone was considered fair, while copper-rotenone was good for leafhoppers in victory gardens in Indiana.--Reed (496).

Pyrethrum can be substituted for rotenone for the control of leafhoppers.--Turner and Horsfall (606).

Coccidae

Aonidiella aurantii (Mask.), the California red scale

Promising results, obtained with sprays of petroleum oil and cube and derris resins, led to a study of the relative susceptibility of the resistant and nonresistant strains of this scale. When the two strains were sprayed with the oil-cube resin the resistant strain showed a greater survival in every case. A light-medium oil with cube was just as effective as a heavy oil with it; however, mortality when light oil alone was used on heavily infested old wood was 51.6 percent while heavy oil alone caused a mortality of 58.1 percent. Mortality was increased to 92.9 and 91.2 percent by the addition of cube resins. Both nicotine and cube in oil gave marked increases in mortality of scales on all parts of a lemon tree as compared with oil alone. In heavy infestations on old wood the addition of cube resins increased the mortality from 12.8, 58.1, and 58.6 percent to 43.9, 91.2, and 94.5 percent for the applications of 1, 1.5, and 2 percent of oil, respectively. Experiments with a tank-mix oil showed that the addition of derris resins increased the mortality of the red scale, but that 1.14 percent of resins in oil was no more effective than 0.57 percent. In regard to one type of emulsive oil, scale mortality was proportionate to the amount of cube or derris resins in the oil over a wider range of resin concentrations.--Cressman (123-125); Cressman and Broadbent (126).

In recent years the addition of derris resin (25 percent of rotenone) in suitable mutual solvents showed promise. Oil-toxicant sprays, in which 10 percent of derris resin in dibutyl phthalate was added to the oil, resulted in a greater mortality of the red scale. The effectiveness of derris and cube extracts was best demonstrated by the great increase in the toxicity of a kerosene spray made possible by the addition of a stock solution with 39 parts of kerosene (resulting in 0.031 percent of rotenone in the kerosene). Used at a 10-percent dosage with 4 ounces of calcium caseinate spreader per 100 gallons, the toxic kerosene often killed practically all red scales hit by the spray. Promising results were also had by soaking finely ground derris or cube root in unheated kerosene for 30 minutes. In 1942 the kerosene-rotenone spray was not yet recommended for it had killed a considerable number of trees. In 1943 finely ground cube root (5 percent of rotenone), at 1 pound to 100 gallons of spray, was used effectively as a supplement to spray oil. A properly prepared oil-toxicant solution will result in more improved red scale condition, than oil alone, even at long periods after treatment. Few, if any, of the scales succumb to the treatment if oil alone is used, but if derris or cube extractives are added to the oil, a large percentage of scales not receiving enough oil for suffocation are nevertheless killed by the treatment.--Ebeling (153-156); Ebeling and LaDue (157).



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It was shown chemically and by use of the red scale that rotenone and derris-containing preparations decompose when incorporated into spray materials. All these spray materials should be protected against the adverse effects of atmospheric oxidation, sunlight, and high temperatures. The toxicants used are drastically short-lived under field conditions.--Gunther (249).

In a chemical study of solubilizers for petroleum oils and extracts of rotenone-bearing roots it was remarked that toxicological evidence points to the fact that certain heterogeneous compositions are effective for control of the red scale and black scale, possibly because the active constituents of the extract are in solution.--Kagy and Boyce (334).

Extensive tests in several southern California citrus districts showed that rotenone materials added to oil sprays gave a high kill. In a 5-year spraying program on a large commercial orchard, applications of rotenone and light medium oil in the spring and again in the fall kept the trees comparatively free of the red scale, and eliminated all other pest control problems except thrips. Kerosene or light oil which give 70 to 87 percent mortality will, upon the addition of derris or cube products, cause 96 percent mortality. Heavier oils which are more efficient than light oils may also be increased in effectiveness by rotenone. Rotenone is equally effective whether in complete solution or in suspension in the spray. A minimum of 25 grams of derris or cube resins per 100 gallons of finished spray material appears to be necessary.--McBeth and Allison (373, 374).

Rotenone incorporated in oil may make possible the more effective use of oils of even lighter grades than those used in 1941. The need for improvements in control of the red scale where the resistant strain occurs has been urgent, and up to 1941 there was considerable promise in the kerosene-rotenone spray.--Quayle (482, p. 9; 483).

In field tests against the California red scale, the addition of cube extract or nicotine to mineral-oil emulsions increased their effectiveness to a marked extent, particularly against scales on wood where oil alone was less effective. Extracts of rotenone-containing plants were more toxic in oil sprays than nicotine, the most effective combination having been cube resins in a soluble oil. In field trials the percentage mortalities of adults on grey wood and on fruit were increased from 36 to 76 and from 82 to 96, respectively, by the addition of cube resins to the spray. An increasing proportion of the total spray mixture deposited on the wood became insecticidally active as the deposits increased.--U. S. Bureau of Entomology and Plant Quarantine (618, p. 7; 619, p. 9; 623, p. 9).



Aspidiotus perniciosus Comst., the San Jose scale

The percentage of scale-infested apples was 0.2 and 1.4 on trees that received lead arsenate in the first two cover sprays, followed with nicotine in summer oil in the other six sprays; 10 percent on trees treated with lead arsenate in the first two sprays, followed with rotenone in the remaining six sprays; and 21.8 percent on trees untreated.--Harman (265).

Eriococcus azaleae Comst., the azalea bark scale, azalea mealybug

Sprays containing 1.5 gallons of white-oil emulsion with the addition of either 1.5 pounds of derris or 1 pint of nicotine sulfate in 100 gallons of water gave excellent control.--English and Turnipseed (168).

Lepidosaphes beckii (Newm.), the purple scale

In tests on small potted trees, derris was more effective as a toxic supplement when used with Mineral Seal oil and diglycol oleate than when used with either component of the emulsion.--English (167).

Parlatoria chinensis Marlatt

The addition of cube resin to low concentrations of oil in dormant applications increased the efficiency markedly. In summer applications rotenone markedly improved the efficiency of low concentrations of light-medium summer oils; 1 percent oil containing 0.01 to 0.02 percent of cube resins (16.4 percent of rotenone) was nearly equal in efficiency to 3 percent of the same oil without the added toxicant. Also, 1 percent concentration of the same oil which contained 0.05 percent of rotenone in stock emulsion gave a high degree of control.--Baker and coworkers (31).

Pseudococcus comstocki (Kuw.), the Comstock mealybug

Oil combined with rotenone-bearing insecticides showed promising results against the young crawling mealybugs.--Cox (122).

Pseudococcus cuspidatae Rau, taxus mealybug

IN-2018 killed 90 to 95 percent of the mealybugs; Righto about 95 percent; and IX plus 0.4 percent of soap, about 95 percent. Each was diluted 1:400. The first proprietary mixture was a rotenone spray containing a special wetting agent; the second one was a rote-



none and oil spray; and the third was a rotenone-pyrethrum-oil spray. A nicotine and soap spray was distinctly better than these materials.--Hamilton (252).

Saissetia oleae (Bern.), the black scale

Low concentrations of oil with rotenone were more effective against the larger adults than oil at the full concentration.--Boyce and coworkers (80, 81).

For the combined control of this scale, aphids, and the red mite, a spray consisting of light-medium oil ( $\frac{1}{2}$  to  $\frac{3}{4}$  percent) with rotenone may be used.--Quayle (482, p. 26).

#### Delphacidae

Sogatia furcifera (Horv.), rice hopper

The control measures recommended in Fiji were draining the rice fields, spraying the plants from a watering can with a suspension of 1 pound of derris in 10 gallons of water, or scattering rice bran impregnated with kerosene on the water in the fields.--Lever (362).

#### Derbidae

Proutista moesta (Westw.)

This insect on sugar cane in the Philippine Islands can be controlled by spraying with soap solution and nicotine sulfate or derris powder.--Otanés and Karganilla (453).

#### Psyllidae

Paratrioza cockerelli (Sulc), the potato psyllid, tomato psyllid

A derris dust (0.5 percent of rotenone) and pyrethrum powder (0.17 percent of pyrethrins) were ineffective against the nymphs on tomatoes.--List (366).

#### HETEROPTERA

#### Cimicidae

Cimex lectularius L., the bedbug

Household sprays containing pyrethrum and derris are usually applied in Southern Rhodesia to combat minor infestations or as a routine precaution against infestation, but they may in time considerably reduce even major infestations.--Mossop (431).

Coreidae

Aconthocoris sordidus (Thnb.)

The control measures recommended against this bug on vegetables in Japan are hand collection, spraying with derris in soap solutions, and dusting with a mixture of pyrethrum and ash.--Yamazaki (703, 704).

Lygaeidae

Blissus hirtus Montd., the hairy chinch bug

Experiments with 1- and 0.5-percent rotenone dusts and tobacco dust (1 percent of nicotine), applied at the rate of 25 pounds to 1,000 square feet, were conducted on a very heavy, dense turf. The three dusts were about equal in effectiveness and excellent kills were obtained by all three.--Johnson (330, 331).

A machine was designed which uses new principles in the application of dusts to turfs. Economic control may be obtained with one-third the amount of 1-percent rotenone dust formerly recommended. Rotenone is highly toxic to all stages.--Pyenson (479).

NNOR (1:800) applied to turf gave 89 percent mortality of the hairy chinch bug, while derris (4 percent of rotenone) gave 92.5 percent.--Roth and Pyenson (517).

Blissus leucopterus Var. insularis Barber (=insularis Barber), a chinch bug

Emulsions of lubricating and fuel oils, strong soap solution, diluted pyrethrum extract, and local proprietary dusts of nicotine or derris were ineffective against this species infesting lawns in Trinidad.--Pickles (468).

Geocoris moderatus Montd.

Nysius natalensis Evans

These insects were found in great numbers in South Africa, where their presence was associated with poor turf which was improved by treatment with derris.--Omer-Cooker and coworkers (450).

Nysius turneri Evans

Liberal applications of derris dust to food plants in Tasmania drive away the bugs and protect the plants for 2 to 4 days.--Evans (172).

Phaenacantha marcida Horv.

Excellent control of the adults on sugar cane in Formosa was given by a spray of nicotine sulfate, while one containing a proprietary preparation of derris and soap was slightly less effective.--Takahashi (578).

Miridae

Calocoris fulvomaculatus (Deg.), shy bug

The active stages of this bug on hops in England are controlled by nicotine or derris sprays applied to the vines.--Massee (400).

Campylomma verbasci (Meyer), mullein leafbug

Nicotine, pyrethrum, and derris sprays in combination with wetting agents gave good control.--Cameron (100).

Following a serious outbreak on apple in Nova Scotia, a proprietary rotenone spray (Berako) was applied. A marked reduction in infestation was observed, but not complete control.--Pickett and coworkers (467).

Engytatus tenuis Røut.

A considerable reduction in the numbers of this insect was brought about in Sumatra by the application of a spray containing 0.2 percent of derris powder (10 percent of rotenone) and 0.1 percent of soap.--Laan (350, p. 56).

Helopeltis antonii Sign.

A mixture of derris and talc considerably reduced the number of both nymphs and adults on cacao in Java in 1938. In large-scale field experiments in 1940 the preceding result was confirmed, and it was shown that even on full-grown trees this pest could be controlled satisfactorily by applications of a derris dust containing 0.75 percent of rotenone (1 part of derris powder of 10-percent rotenone content mixed with 13 parts of talc), with a resulting increase of crop yield. In 1941 it was confirmed that thorough applications at fortnightly intervals of a sufficiently fine derris dust were very effective.--Betram (46, 47, 48).

Helopeltis can normally be controlled on tea in Java by a derris dust (0.75 percent of rotenone). The rate of application for dusting ranges from 2.7 to 7.2 pounds per acre, but if a heavy infestation spreads to the whole plantation, up to 27 pounds per acre must be used, which is usually unremunerative.--Verbeek (639).

Lygidolon laevigatum Reut.

In laboratory tests in South Africa pyrethrum dust was superior to derris against this insect which attacks wattle.--Evens (170).

Lygus atriflavus Knight

In laboratory test a dust containing 0.125 percent of pyrethrins and 0.5 percent of rotenone gave good kills of the nymphs and adults. Kills approaching 90 percent were obtained in the field with this dust but the fields were soon heavily reinfested.--Fisher and Shull (187).

Lygus campestris (L.)

Spraying with powdered derris and a wetting agent is helpful and will give satisfactory control if the applications are started while the infestation is light.--Whitcomb (679, p. 39).

Lygus elisus Van D.

Lygus hesperus Knight

The information given for L. atriflavus also pertains to these two species.--Fisher and Shull (187).

This species can be reduced by the use of a derris dust or a pyrethrum extract.--U. S. Bureau of Entomology and Plant Quarantine (622, p. 70).

Lygus oblineatus (Say), the tarnished plant bug

A spray mixture consisting of derris powder, pyrethrum extract, and sulfonated castor oil with water was effective.--Howard and co-workers (294, p. 31).

Dust roses bearing this bug with copper-rotenone dust.--McDaniel (379).

Against adults there was no significant difference in effectiveness between derris and pyrethrum, but both were more effective than a calcium-arsenate-sulfur mixture.--Smith and coworkers (552).

A proprietary dust containing sulfur, derris, and nicotine was superior to others containing mainly derris, or derris and nicotine, but its action was probably repellent to this species on chrysanthemums in England.--Orchard (451).



The tarnished plant bug can be reduced by the use of mixtures containing either a dust impregnated with a derris dust or a pyrethrum extract.--U. S. Bureau of Entomology and Plant Quarantine (623, p. 70).

Poecilocapsus lineatus (F.), the four-lined plant bug

Roses infested with this bug should be treated with copper-rotenone dust.--McDaniel (379).

Pentatomidae

Aelia sp.

In laboratory and field experiments in Germany dusting with derris caused no mortality of adults.--Tischler (593).

Antestia lineaticollis (Stål)

The use of a strong water extract of Tephrosia vogelii as a contact or stomach poison, and in baits, proved completely inadequate as a control of this bug on coffee in Uganda.--Taylor (584).

In experiments conducted in the Belgian Congo a pyrethrum dust acted more quickly than did a 5.3-percent rotenone dust, and much more quickly than a dust prepared from the leaves of T. vogelii.--Lefevre (361).

Dolycoris sp.

Eurygaster sp.

No mortality of adults of these bugs was given by dusting with derris in Germany.--Tischler (593).

Euschistis tristigmus (Say)

Euschistis variolarius P. de B.

Derris dust (1 percent of rotenone) did not control these pentatomids on tomatoes.--Mundinger (433).

Murgantia histrionica (Hahn), the harlequin bug

Because of the adhesiveness of talc, derris-talc mixtures were more effective in laboratory tests than derris-sulfur mixtures or derris alone. Dusts of derris, timbo, or Tephrosia containing talc

and 0.2 percent of rotenone gave 100 percent mortality in 48 hours, whereas cube with talc gave only 88.6 percent. In field experiments two applications of dusts of derris and talc containing 1 percent of rotenone and 10 percent of flour gave 96 percent control of this pest on cabbage and collards.--Arant (22, 23).

In laboratory tests certain natural and sulfonated vegetable oils combined with derris or cube increased significantly the toxicity of the rotenone material.--Fulton and Howard (206).

Rotenone is relatively more effective than nicotine against the harlequin bug.--Isely (311, p. 25).

Spray or dust with derris or cube. This is the only insecticide recommended.--U. S. Bureau of Entomology and Plant Quarantine (617).

There is no comparable substitute for rotenone.--U. S. Department of Agriculture (633, p. 14).

Nezara viridula (L.), the southern green stinkbug

Dusts of derris and talc were effective against small nymphs, but all the rotenone insecticides tried were ineffective against the large nymphs and adults.--Arant (22, 26).

This species and Cuspicona simplex Wlk. are both called the green vegetable bug in Queensland. A derris spray containing .02 percent of ether extractives, prepared from powdered derris-soap or liquid derris proprietary products, was of some value against the nymphs on tomatoes.--Sloan (546).

Rhoecocoris sulciventris (Stål), a bronze orange bug

High concentrations of derris sprays gave good mortalities in Queensland. The fourth-instar nymphs were more resistant than the adults.--Smith (553).

Rhynchocoris humeralis (Thnb.)

In Formosa control measures comprise hand collection of all stages and spraying with derris against the nymphs.--Takahashi (579).

Other pentatomids

On cotton in Arizona 53 species of Hemiptera were found, the more important injurious ones being 3 species of pentatomids and 4

species of mirids. Sodium fluosilicate gave an increase in yield of 517 pounds of seed cotton per acre, and derris (4 percent of rotenone), 151 pounds. A year later lead arsenate gave 523 pounds and derris-sulfur, 206 pounds.--Cassidy and Barber (106).

### Pyrrhocoridae

Dysdercus fasciatus Sign., a cotton stainer

In Africa a bait including 5 percent of derris powder (5 percent of rotenone) was almost as toxic as sodium arsenite and much more attractive.--Rainey (488, p. 48).

### Tingitidae

Stephanitis pyrioides Scott, the azalea lacebug

A spray containing 0.83 percent of oil and 1.5 pounds of derris (5 percent of rotenone) per 100 gallons of water was effective in control. For the eradication of infestations in nurseries, applications should be made every 3 weeks. A 3-percent nicotine dust and a dust containing 0.75 percent of rotenone were ineffective.--English (166); English and Turnipseed (168).

Teleonemia nigrina Champ.

Derris dust was unsuccessfully tried to control this tingitid on snapdragon plants.--Hixson (287).

### DIPTERA

### Agromyzidae

Agromyza oryzella Mats.

Sprays of nicotine sulfate (1:800 and 1:1000) were tested in Japan. The stronger one killed all the eggs and more than 90 percent of the larvae, while the weaker one and a derris spray each killed more than 90 percent of the adults and larvae.--Okazaki (449).

### Bibionidae

(Dilophus) Philia febrilis (L.), fever fly

The larvae damage roots of grass in lawns. Field experiments were carried out in three heavily infested areas in Wales. The

mortalities were 91.9 to 94.9 percent when a derris suspension containing 0.0054 percent of rotenone was applied to the turf at the rate of 1 gallon per square yard; 97.9 to 98.9 percent when pyrethrum extract was added to this to give a content of 0.001 percent of pyrethrin I; and 99.6 to 99.7 percent when lead arsenate was uniformly distributed over the turf at the rate of 1.5 ounces per square yard and watered into the soil with 1 gallon of water per square yard.--Edwards (160).

#### Calliphoridae

Calliphora erythrocephala Mg., the blue-bottle blowfly

The results obtained are in agreement with the work of Morozov and Alexandrov, acting singly, on the permeability of the insect cuticula to various substances, while Fulton and Howard have shown that the toxicity of derris inside the insect may vary with the nature of the oil carrier used.--Hurst (302).

Calliphora stygia (F.), a blue-bottle blowfly

(Lucilia) Phaenicia cuprina (Wied.), a green-bottle blowfly

(Lucilia) Phaenicia sericata (Mg.), the green-bottle blowfly

None of the substances tested, including derris (19 percent of ether extract), showed promise as a substitute for sodium arsenite or calcium arsenite in the mixtures used for the control of blowflies on sheep in Australia.--McCulloch (376).

#### Culicidae

Aedes cinereus Mg.

In a glass chamber derris dust was more effective than pyrethrum powder.--Mironov and coworkers (420).

Aedes concolor (Tayl.)

Ground derris root was equally as toxic to larvae of this species in sea water as to larvae of Culex (fatigans) quinquefasciatus in fresh water.--Pasfield and Woodhill (458).

Aedes spp.

In India complete mortality of mosquito larvae of this genus and of Anopheles and Culex was obtained in 24 hours with an acetone extract of Tephrosia vogelii.--Chopra and coworkers (115).



Chaoborus astictopus D. & S., the Clear Lake gnat

Derris powder (5 percent of rotenone), tested as a larvicide against this nonbiting midge, was less effective than pyrethrum.--Deonier and Lindquist (140).

Culex pipiens L., the northern house mosquito

In a glass chamber derris dust was more effective than pyrethrum powder.--Mironov and coworkers (420).

Culex quinquefasciatus Say, the southern house mosquito

Ground derris root was toxic to all instars of the larvae. The minimum concentration necessary for 100 percent mortality rose with each succeeding instar, and the concentration necessary to kill the early third instar in 48 hours was 0.01 gm. per 1000 cc. When no food material was available the minimum concentration necessary for 100 percent mortality was lowered, as was also the time taken for this mortality.--Pasfield and Woodhill (458).

Unidentified mosquito larvae

An extract of the fruit of the Amur cork tree (Phellodendron sp.) was more toxic to mosquito larvae than was a derris extract (5.2 percent of rotenone).--Haller (250).

Thanite was reported to be an effective substitute for pyrethrum or rotenone in household sprays against mosquitoes, cockroaches, and other pests.--[Hercules Powder Company] (277).

Acetone extracts of the seeds of Tephrosia vogelii were lethal to both anopheline and culicine larvae in India up to 1 in 2,000. This action was due to deguelin, an isomer of rotenone.--Manson (393).

Xanthone was more toxic than rotenone to mosquito larvae, having been effective at a concentration of 1:1,000,000.--U. S. Bureau of Entomology and Plant Quarantine (624, p. 53).

Gasterophilidae

Gasterophilus haemorrhoidalis (L.), the nose botfly

Gasterophilus intestinalis (Deg.), the horse botfly

Gasterophilus nasalis (L.), the throat botfly

Derris powder and rotenone crystals were given with feed to

animals, but the results obtained were not conclusive. When derris powder was tested on botfly larvae, under laboratory conditions, it killed slowly and, in some cases, required retreatment to secure a kill.--Haseman and Roland (269).

### Hippoboscidae

Melophagus ovinus (L.), the sheep tick, sheep ked

When pupae of mixed ages were immersed in a solution of rotenone the percentage of emergence was not materially affected.--Commonwealth of Australia (118, p. 30).

Derris is particularly suitable for the control of the sheep ked.--Freak (199).

There are three kinds of dips used for eradicating sheep ticks at one dipping, namely, fused-bentonite-sulfur-cube, arsenic-sulfur-rotenone, and home-made derris or cube dip. When used according to the instructions furnished, they are effective.--Imes and Babcock (307); Thomssen and Doner (591).

All the preparations containing arsenites, phenols, and rotenone were effective in New Zealand against the adult keds on sheep, and trials indicated that derris gave the necessary delayed action so that the keds emerging from pupae were also killed.--New Zealand Department of Science and Industry (445).

A rotenone-sulfur dip was tested in New York on about 2,000 sheep, representing a number of farm flocks and all the common breeds. In addition, three county rings used this formula on approximately 10,000 head. The result was the eradication of the sheep tick in all flocks dipped. Only one dipping was necessary, and this usually occurred shortly after shearing. While this dip does not kill the pupae it remains effective long enough to kill all young ticks emerging from the pupae which were present at the time of dipping. The formula follows: Cube (5 percent of rotenone) 10 pounds, wettable sulfur 100 pounds, and water 1,000 gallons. Wettable sulfur alone will usually eradicate this pest but it is too slow, and a fixed nicotine-sulfur dip was also good but was not uniformly efficient.--Schwardt and Matthysse (530).

In 1942, 700 sheep infested with this pest in Colorado were dipped once in a suspension of 4 ounces of derris powder (5 percent of rotenone) per 100 gallons of water. None became reinfested during frequent inspections in the course of the following 92 days, during which time they mingled with infested sheep.--U. S. Bureau of Animal Industry (613).

An improved and inexpensive dip that can be prepared on the farm or range was made in 1943 by adding 4 to 6 ounces of cube powder to each 100 gallons of water. With nearly 10,000 farm and range sheep that were dipped in Colorado and New Mexico during 1944, a single dipping destroyed all ticks in a relatively short time. The dip material apparently remained in the fleeces of dipped sheep long enough to destroy any young ticks that developed from the live pupae remaining in the wool after dipping. The cost of this home-made dip is only 10 to 20 percent of that charged for commercially prepared dips. The use of this dip was one of the high lights of the year's scientific work.--U. S. Bureau of Animal Industry (614).

Pseudolynchia canariensis (Macq.), the pigeon fly

One of the most easily applied and effective treatments for squabs is fresh pyrethrum powder. From 1 to 3 pinches dusted in the feather tufts will kill all flies present. Derris or cube powder (3 to 5 percent of rotenone) is nearly as effective as pyrethrum and should be used in the same way, but these powders are less effective on grown pigeons.--Bishopp (53), and U. S. Bureau of Entomology and Plant Quarantine (627, p.24).

#### Hypodermatidae

Hypoderma aeratum Aust.

In Cyprus dressing the warbles on goats with derris preparations gave satisfactory results.--Roe (511).

Hypoderma bovis (Deg.), the northern cattle grub

Hypoderma lineatum (De Vil.), the common cattle grub

In Cyprus dressing the warbles with a derris preparation was found to be a cheap and effective means of destroying the larvae of both species. Arrangements were made in 1937 to treat large numbers of cattle in different parts of the colony. In 1938 investigations indicated the advisability of treating all cattle in an endeavor to eradicate these flies from the island. The government approved a 3-year scheme that entailed the examination of all bovines once a month from December to April and the application of a derris preparation to every warble that could be seen or felt.--Roe (511, 512).

In Germany the best insecticide for both species was a suspension of derris in soap solution which kills the larvae at any stage

of development of the warbles. The derris root should yield 8 percent of rotenone and 25 percent of residual extract, and two applications with a 2 percent suspension, with a 2-day interval, were more effective than a single application of a 4 percent suspension.--Bartels (35).

In experiments with derris in Germany the most effective remedies for these flies contained rotenone or other extractives in the ratio of 1:2. Several proprietary extracts containing 8 percent of rotenone and 16 percent of other extractives were marketed. Two thorough applications of a wash containing 2 to 4 fluid ounces in 5 pints of water killed 95 to 100 percent of the larvae under the skin.--Götze (238).

In Great Britain the use of derris as a dressing for cattle grubs was suspended. Owing to lack of supplies nicotine was used in place of derris.--Great Britain Ministry of Agriculture (243).

It was reported in 1940 that work on the control of cattle grubs with the derris treatment in 10 districts of British Columbia had progressed satisfactorily for 6 years. In one district alone 15,000 cattle were treated.--Gunn (248).

Experiments were carried out in 1938 with washes of 4 ounces of white flaked soap in 1 gallon of water to which was added 1 pound of derris powder (5 percent of rotenone) or 1 ounce of rotenone. When applied to warbles with a bristle brush or with a soft brush, the derris wash killed 96.7 and 75.8 percent of the larvae, respectively, and the rotenone wash killed 83.2 and 61.6 percent.--U. S. Bureau of Animal Industry (610).

The formula recommended in 1940 for the control of both species of cattle grubs was: Water 1 gallon, cube or derris powder 12 ounces, and soap 2 ounces. One gallon of this was sufficient to treat the backs of 12 to 16 adult cattle, the cost of materials being about 2 cents per head per treatment.--Wells (671).

A single dipping in the sulfur-cube dip killed a very small percentage of cattle grubs, but two dippings at intervals of 17 to 19 days killed 67.3 percent, in 1940.--U. S. Bureau of Entomology and Plant Quarantine (619).

In experiments in 1941 to control both species of cattle grubs, derris was combined with soap and water as a wash, then rubbed vigorously with a stiff brush; or derris combined with a light oil, was injected into the warbles with an oil can; or derris, combined



with heavy paraffin oil, was pressed into the warble openings with the fingers, or injected with a large hypodermic syringe with the needle removed. In all herds so treated the derris preparations gave practically 100 percent kill of the grubs.--Haseman and Roland (269).

There was little difference in effectiveness in 1941 between washes of derris and cube powders mixed at the time of treatment, and washes containing derris and soap powders, or 12 ounces of derris and 4, 6, and 8 ounces of fused bentonite sulfur. The percent effectiveness of single treatments ranged from 60 to 100, with an average of about 90. The washes reached maximum effectiveness in 10 to 15 days and ceased to be effective 25 to 30 days after application.--U. S. Bureau of Animal Industry (612).

Derris and cube washes in 1941 were more effective than chemically pure rotenone or a preparation containing 90 percent of rotenone. Derris and cube powder (4 percent of rotenone) were as effective as those containing 5 percent of rotenone, and washes made with 12 ounces of powder to 1 gallon of water were as effective as those made with 16 ounces and were safe and efficient, but washes containing only 8 ounces of powder were not fully effective. Single treatments of infested cattle with washes made of 12 ounces of derris or cube, 4 ounces of soap flakes, and 1 gallon of water gave 90 to 100 percent kill. The washes were applied to the back and upper parts of the sides of cattle with stiff brushes at the rate of about 1 pint per animal.--Smith, Livengood, and Roberts (548).

Cattle growers reported that the louse powder controlled warbles even though it contained only 1 percent of rotenone. An abundance of rotenone at 2.5 percent strength was made available for warbles in large herds, but under the WPB regulations none was available for lice.--Clemson Agricultural College (116).

Cattle grubs are best controlled by applications of powdered derris or cube root to the backs of the infested animals. These powders may be applied in the form of a wash, dust, or spray, and full directions for applying each are given.--Smith and coworkers (554); U. S. Extension Service (634)

In experiments in Colorado, New Mexico, and Texas, in which a commercial hymolosalat was substituted for soap in derris and cube washes for the control of ox warbles, about 91 to 97, 75 to 80, and 37 to 52 percent control, respectively, was effected.--U. S. Bureau of Animal Industry (613).

The application of rotenone suspensions on the backs of cattle was greatly expedited and simplified by use of a power sprayer and a regular orchard gun, the spray having been directed vertically downward on the backs of the cattle in an ordinary cattle chute. The spray recommended consisted of cube or derris powder (5 percent of rotenone) 5 pounds, wettable sulfur 10 pounds, and water 100 gallons. This method would appeal especially to owners of large ranch herds.--Wells (672).

Cube-sulfur wash may be applied to the backs of the cattle with a brush.--Laake and coworkers (348).

Cube and derris powders applied dry in combination with wettable sulfur were fully as effective as when they were applied as washes or sprays. The dust mixture was not so effective as the wash on cattle with dense coats of hair, but it can be applied more rapidly than the wash and it had found favor with the owners of small farm herds and dairy herds.--Laake (347); Wells and Laake (673).

Ox warbles might be satisfactorily controlled by placing range cattle in chutes and spraying them with 10 pounds of wettable sulfur, 10 pounds of derris (5 percent of rotenone) to 100 gallons of water to which a detergent should be added. This spray was not effective in controlling these grubs in dairy cattle when applied as a wash with a stiff brush.--Stewart (569).

In Idaho both species of cattle grubs are common and the control methods are fully described, including the hand wash method, hand dust method, and power sprayer method.--Shull and Fisher (540); U. S. Department of Agriculture (632).

The oft-recommended procedure of extracting the grubs by hand and the chemical methods of control are effective only after the grubs perforate the hide for their oxygen supply. For large herds a rotenone preparation consisting of 12 ounces of cube or derris powder and 6 ounces of wettable sulfur per gallon of water make a very effective wash for application to the backs of cattle.--Thomssen and Doner (591).

There is no known substitute for rotenone in the treatment of large numbers of animals infested with cattle grubs. Extracts of derris or ground derris root diluted with pyrophyllite or tripoli earth to a rotenone concentration of 1.25 percent was recommended.--U. S. Bureau of Entomology and Plant Quarantine (628).

In September 1943 the rotenone was reduced in dusts for cattle grub treatments. The rotenone dusts mixed with tripoli earth or with pyrophyllite are more efficient than those made with talc or sulfur, because the former penetrate the hair better and also because twice as many animals or more can be treated with the same amount of derris. Two dust formulas were recommended: (1) Ground cube or derris (5 percent of rotenone) 1 part by weight, and tripoli earth (No. 200 sieve fineness) 3 parts by weight; and (2) cube or derris, the same as in (1), and pyrophyllite (No. 325 sieve fineness) 4 parts by weight.--U. S. Bureau of Entomology and Plant Quarantine (629).

Nearly 800 cattle were treated in Colorado, New Mexico, and Texas in 1943 for cattle grubs. Indications are that dipping cattle in a suspension prepared by adding cube powder (5 percent of rotenone) at the rate of 10 pounds per 100 gallons of water is as effective, in many cases, as the use of washes and dusts containing cube or other rotenone-containing substances. In some instances dipping is more effective than the latter methods.--U. S. Bureau of Animal Industry (614, p. 86).

Rotenone to treat cattle for cattle grubs costs less than 10 cents per animal per season. It would be possible to kill every cattle grub in Idaho during one season if all cattle producers and feeders would cooperate in the control program.-- Shull (539).

In Kansas a State campaign was conducted against cattle grubs in 1944. In 1943, 116,000 cattle were treated, and in 1944 it was planned to treat 1,000,000. In a demonstration for county agents and farmers, four methods were shown: (1) The old method of squeezing the grubs from the backs of animals, (2) the wash method of applying the cube-wettable sulfur, (3) the dust method of applying the cube-tripoli earth, and (4) the spray method of applying the rotenone preparation with a sprayer.--Kelly (340).

The effectiveness of the following dusts was found to be in the order in which they are given below:

	Parts by weight
Ground cube or derris (5 percent of rotenone)---	1
Double-ground cream tripoli earth -----	2

or

Ground cube or derris (5 percent of rotenone)---	1
Volcanic ash (micronized)-----	2

or

	Parts by weight
Ground cube or derris (5 percent of rotenone)---	1
Pyrophyllite (90 percent to pass through a No. 325 screen)----	2

The following spray formula at 400 pounds' pressure was found satisfactory:

Cube or derris powder (5 percent of rotenone)----	7.5 pounds
Water-----	100.0 gallons

The following wash formula is recommended:

Ground cube or derris (5 percent of rotenone)----	12.0 ounces
Granular laundry soap-----	4.0 ounces
Warm water-----	1.0 gallon

The following formula is used for dips:

Ground cube or derris (5 percent of rotenone)----	10.0 pounds
Wetting agent (sodium lauryl sulfate)-----	2.0 ounces
Water-----	100.0 gallons

--U. S. Bureau of Entomology and Plant Quarantine (631).

#### Itonididae

Contarinia humuli Tölg., hop strig maggot

Satisfactory control was given in tests in which derris and nicotine dusts were applied against the adults on hops in England in late July. A derris dust was later applied to the soil just before the larvae left the cones.--Massees (400, 402).

Contarinia pyrivora (Riley), the pear midge

In Denmark the measures adopted against the adults included four applications of a nicotine spray, and dusting the pear trees and soil with derris.--Bovien (77).

Dasyneura mali Kieffer, the apple leaf-curling midge

Good control was secured with sprays containing 3 pounds of fixed nicotine or 5 pounds of ground derris.--Parrott (457).



Spraying during the height of the oviposition period of the second generation caused a measurable reduction in the number of infested tips where a rotenone or a DN spray was used, but no reduction where a pyrethrum spray was used.--Whitcomb (680, p. 38).

Dasyneura vaccinii Smith, a cranberry tipworm

Preliminary tests indicated that this pest can be controlled by rotenone sprays.--Crowley (128).

Diarthronomyia hypogea (Loew), the chrysanthemum gall midge

The time of day at which nicotine or rotenone-pyrethrum sprays were applied appeared to have little significant difference on the degree of control secured, although sprays applied after 2 were slightly more effective than earlier applications.--Dustan (152).

Mycodiplosis alternata Felt, dogwood club gall midge

Four applications of sprays containing 4 pounds of rosin residue emulsion and 4 pounds of cube powder per 100 gallons of water appeared to be effective.--Felt and Bromley (178).

#### Muscidae

Hylemya brassicae (Bouché), the cabbage maggot

Powdered derris root had no influence on the amount of maggot injury.--Glasgow (232).

(Haematobia) Siphona irritans (L.), the hornfly

Rotenone, administered by mouth to stock, was the most effective material tested; when given to cattle daily at the rate of 0.4 gram per 100 pounds of body weight of the animal, it killed all the fly larvae in the droppings. It had no apparent harmful effect on the cattle.--Bruce (93, 94).

It is possible to administer certain chemicals orally to cattle which render the droppings unsuitable for the development of hornfly larvae, but this method has not reached the practical stage. Effective materials include rotenone (0.4 gm. per 100 lb. of body weight), zinc oxide, and phenothiazine.--Thomssen and Doner (591).

When pyrethrum or rotenone sprays were applied to animals to control the hornfly, the toxic action persisted almost undiminished for at least 7 hours.--U. S. Bureau of Entomology and Plant Quarantine (623, p. 94).

Musca domestica L., the housefly

In a study of the toxicity of poisons applied jointly, the numerical relations are illustrated by a test on the toxicity to the housefly of solutions containing pyrethrin and rotenone. A mixture with a little less than four equitoxic units of pyrethrin to one of rotenone agreed closely with the definition, but one in which the ingredients were about equally balanced showed a significantly greater toxicity than expected on the hypothesis of independent action, indicating the presence of synergism.--Bliss (58).

The terms "synergism" and "antagonism" have been used to describe modes of action of mixtures in which the toxicities are respectively greater or less than those predicted from the separate constituents. This definition is illustrated by an analysis of data obtained by Le Pelley and Sullivan in tests on the toxicity of rotenone and pyrethrins and mixtures of these poisons to M. domestica, in which tests synergistic action was demonstrated.--Finney (186).

In a study on the effect of using reduced dosage and reduced time exposure in the Peet-Grady test, experiments were carried out with two finished sprays, one containing 150 mg./100 ml. pyrethrins (equivalent to 7.5 percent of pyrethrum 20:1 concentrate), and the other 55 mg./100 ml. pyrethrins plus 50 mg./100 ml. of c. p. rotenone, both in a deodorized kerosene base. The reduction of exposure from 10 to 5 minutes did not cause any substantial changes in the knockdown and kill of houseflies when the standard 12 ml. dosage was used. The reduction of exposure time caused a noticeable decrease in knockdown and kill when the 6 ml. dosage was used. The reduction of the dosage from 12 ml. to 6 ml. caused a decrease in both knockdown and kill. The reduction of exposure time did not appear to have any adverse effect upon the accuracy of the results.--Ford (191).

The roots of Tephrosia virginiana used in a study contained 1.2 percent of rotenone and 6.7 percent of total extractives. Three fractions of the noncrystalline portion were prepared, and the toxicity of each to the housefly was compared with that of rotenone. The neutral-resin fraction which comprised approximately 50 percent of the total extractives had considerable toxicity, but the alkali-solution portion (9 percent) and the oil (23 percent) were nontoxic. The two crystalline compounds which were isolated from the neutral resin were nontoxic to the housefly. In recent tests comparing the toxicity of smoke from burning derris and burning pyrethrum, derris was much more toxic to the housefly while the cockroach was more susceptible to pyrethrum. Fumigation with rotenone and pyrethrum in the form of a smoke or aerosol is discussed, and methods of

stabilizing and increasing the insecticidal action of these smokes are described.--Goodhue and Sullivan (235, 236).

An extract of the fruit of the Amur cork tree was about as toxic as derris extract to the housefly.--Haller (250).

In a study on the effect of sesamin and related compounds on the insecticidal action of pyrethrum on houseflies, it appears that the nature of the substituents on the benzene ring is the determining factor in the synergistic action of this class of compounds, and that their spatial configuration is of little or no importance. In the case of nicotine, rotenone, deguelin, and toxicarol, the optical activity plays an important role in insecticidal action.--Haller and coworkers (251).

Tests demonstrated that Tephrosia virginiana may be successfully substituted for derris and cube roots in housefly sprays. No added solvent was necessary to obtain kerosene extracts of rotenone-bearing roots with a high degree of toxicity. The insecticidal importance of constituents other than rotenone was again emphasized.--Jones and Sullivan (327).

In Russia derris dust at the rate of 0.1 gram per cubic meter was as effective in killing houseflies enclosed in a glass chamber as pyrethrum powder at the rate of 2 grams per cubic meter. Pyrethrum acted more quickly because it paralyzed the flight muscles, but a small proportion of the paralyzed muscles recovered. With derris, death always followed the initial paralysis of the first pair of legs.--Mironov and coworkers (420).

Acetone extracts of the roots of bushy, small-leaved Lonchocarpus plants in Puerto Rico were more toxic to house flies than those of the tall, large-leaved plants.--[Moore] (422).

Against housefly eggs 1.5 to 5 hours old, suspensions of derris powder, derris extract, or rotenone (all used as dips) were the most effective of the materials tested. Derris powder apparently contained water-soluble materials toxic to the eggs in addition to the small quantities of soluble rotenone. The marc remaining after one water extraction was still toxic. Water suspensions of derris extractives or powder appeared to be fairly stable. Extracts from Tephrosia piscatoria and T. virginiana were also toxic.--Richardson (503).

According to the literature, mixtures of rotenone with certain organic thiocyanates display synergistic action against houseflies.--Roark (506).



The seeds and roots of Millettia pachycarpa have long been used as a fish poison and insecticide in China. Against adult houseflies various extracts of the seeds were tested, acetone extract having been the most effective in laboratory experiments.--Chiu and coworkers (114).

Extracts of Tephrosia virginiana were tested on houseflies to determine whether their toxicity would be reduced by extraction on a hot plate and removal of the solvent by heating to determine the total extract. A comparison of the results with those obtained with extracts made by simply shaking the root powder in acetone or chloroform showed no significant differences.--Sievers and Sullivan (541).

Rapidly boiling solutions of derris and pyrethrum produced some vapors toxic to flies, but sprinkling pure rotenone on a hot surface was more effective, and slowly dropping solutions of rotenone and pyrethrum oleoresin in different solvents on a hot surface gave still better results. For this purpose the best solvent used was safrol, with which a copious fog or aerosol was produced on account of its high boiling point. In another paper it was reported that rotenone, levo-dihydro-rotenone, levo-beta-dihydrorotenone, levo-dihydrodeguelin, levodeguelin concentrate, racemic deguelin, and racemic dihydrodeguelin had been tested against the housefly. In acetone solution, the two optically inactive (racemic) compounds were much less toxic than were the optically active ones, but when tested in highly refined kerosene containing cyclohexanone the toxicity of the racemic compounds was approximately the same, or only slightly less, than the optically active compounds.--Sullivan and coworkers (576, 577).

#### Stomoxys calcitrans (L.), the stablefly

Sprays are undoubtedly the best secondary means of control. Rotenone-oil or pyrethrum-oil sprays properly made not only kill all the flies on an animal at the time of spraying but also leave a residue on the coat which for several hours will kill flies attacking the animal.--Bishepp and Laake (56).

Pyrethrins and rotenone were the most effective of the materials tested in controlling the stablefly. When sprays of these were applied to animals, the toxic action persisted almost undiminished for at least 7 hours.--U. S. Bureau of Entomology and Plant Quarantine (623, p. 94).

#### Otitidae

#### Euxesta stigmatias Loew, a corn-silk fly

When pyrethrum extract in mineral oil (1:25) was injected into corn silks infested with the larvae of this fly only 15.8 percent of



them were killed, but when derris powder was added to the pyrethrum-oil mixture, the mortality was 77.2 percent.--Bailey (30).

#### Psilidae

Psila rosae (F.), the carrot rust fly

Only 26.1 percent control of the second-generation larvae resulted from five applications of a derris dust containing 0.75 percent of rotenone. Oil-cube and derris gave unsatisfactory control.--Hanson and Webster (259).

Experiments in England to control the adult fly on early carrots with derris dust (1 percent of rotenone) were unsuccessful.--Petherbridge and coworkers (465).

#### Syrphidae

(Merodon) Lampetia equestris (F.), the narcissus bulb fly

Extended tests with hydrated lime and ground cube root indicated that these materials probably have no practical effectiveness against the larvae.--Schopp and coworkers (525).

#### Tephritidae

Rhagoletis cerasi (L.), the cherry fruitfly of Europe

In Italy the adult flies can be controlled by bait-sprays, or by suspending in trees pans containing a bait of 3 percent of molasses solution poisoned with 0.4 percent of sodium fluoride or derris extract.--Martelli (395).

Rhagoletis cingulata (Loew), the cherry fruitfly of North America

Best results were given by three applications of a spray containing 2 pounds of derris or cube (5 percent of rotenone), 4 pounds of micronized wettable sulfur (as a fungicide), and  $\frac{1}{4}$  pound of soybean flour in 100 gallons of water.--Hamilton (254).

Field tests showed that rotenone-bearing materials and phenothiazine were the only insecticides tested that could be substituted for lead arsenate to control cherry fruitflies. The most satisfactory mixture consisted of derris or cube (5 percent of rotenone) 2 pounds, micronized wettable sulfur 4 pounds, and soybean flour  $\frac{1}{4}$  pound.--Parrott (457).

When nonarsenical sprays are used on sweet cherries, use derris or cube powder (4 to 5 percent of rotenone) 2 pounds, wettable sulfur (at manufacturer's directions), and water to make 100 gallons. Three applications are required.--Mills and Evans (419, p.23).

The most effective chemicals tested were rotenone, calcium antimony tartrate, and basic copper arsenate in spray form. The best contact dusts were 4,6-dinitro-o-cyclohexylphenol and rotenone. Commercial rotenone-bearing roots were more effective as a contact spray than as a contact dust. The effectiveness of rotenone-molasses spray was decreased by the addition of a spreader.--Rosenstiel (516).

One of the more important uses of rotenone-containing roots is to control the cherry fruitfly.--Howard and coworkers (294, p. 30)

Rotenone is effective against cherry fruitflies; nicotine is ineffective.--McIndoo (383).

Rhagoletis completa Cress., a walnut husk fly

Derris or cube dust (1 percent of rotenone) was very effective under laboratory conditions, but under field conditions three treatments at 15-day intervals were unsatisfactory. A mixture of cryolite and derris or cube was not measurably better than cryolite alone.--Boyce and Bartlett (79).

Rhagoletis fausta (O.S.), the black cherry fruitfly

See information on R. cingulata

Rhagoletis pomonella (Walsh), the apple maggot, blueberry maggot

Most of the papers on this species deal with it on apple trees where it is called the apple maggot. In the following three abstracts it is called the blueberry maggot for it was treated on blueberries.

Experiments on the control of this pest on blueberries were conducted in 1939 with dusts of calcium arsenate, and a mixture of derris and pulverized clay containing 2 percent of rotenone. Counts at picking time on the 10-acre plots showed 7 larvae per 20 ounces of berries for the arsenate and 17 for the derris mixture although the plants treated with the latter retained the foliage more completely. In 1940 studies were designed to test the value of an application of the derris mixture following two applications of calcium arsenate, since a third

arsenate treatment was injurious to the plants. Examination of the berries at harvest time showed no reduction in infestation attributable to the derris.--Lathrop (356, 357).

Rotenone is effective against blueberry and huckleberry insects; nicotine is ineffective.--McIndoo (383).

Effective control was observed on apple trees that had received three applications of 0.5-percent rotenone dust.--Garman and Townsend (223).

In 1942 a dust of derris or cube powder (4 percent of rotenone), white lubricating oil, and pyrophyllite (13:4:83), applied to apple trees five times at 10-day intervals, and a spray of  $\frac{1}{2}$  pound of lead arsenate, 2.5 pounds of cube (5 percent of rotenone), and 1 quart of summer oil per 100 gallons of spray, applied four times at 10 to 12-day intervals, reduced the percent infestation to 0.16 to 0.27 and 4.2 to 24.3, respectively, as compared with 20 to 30, and 90 to 100 in 1941, when no treatment was given. It appears that both treatments gave considerable reduction in the apple maggot infestation, with the dust treatment probably exceeding the spray in effectiveness.--Dean (137).

Promising results on apple trees were given by rotenone dusts in 1937. High temperature and high humidity had very little effect in reducing the mortality of oil-impregnated rotenone dusts in the laboratory, but exposure to strong sunlight destroyed the active principles of the dust in a few days. A dust containing 4 percent of white lubricating oil and enough derris to give 0.5 percent rotenone with aluminum silicate retained its effectiveness for 3 hours in bright sunlight in midsummer. When applied to trees it rapidly destroyed the flies at first but they reappeared in 4 to 5 days. When adult flies and artificial sunlight were used there were no significant differences in favor of stabilized derris or the dusts containing oil. Chemical analyses showed that rotenone was less rapidly destroyed when the carrier was red clay than when it was pyrophyllite. Field experiments with oil-impregnated derris dusts (0.5 percent of rotenone) showed that they were of value for late-season work. Five applications of an oil-impregnated dust of derris and pyrophyllite reduced the infestation of picked and dropped fruit to 7.2 and 25.9 percent, respectively, as compared with 87.5 percent for both together in untreated plots. Rotenone dust, such as used in 1939 to 1941, enable one to extend the season of apple maggot control much nearer harvest and to kill much more rapidly than with lead arsenate. Oil-impregnated rotenone dusts may have a place in late season control in order to avoid arsenical residues. Five applications of a 0.5 percent rotenone dust in an orchard in 1942 produced a fairly clean crop of fruit,



although lead arsenate was not applied after the calyx spray of May 16.--Garman (217, 220-222); Garman and Townsend (224).

## ANOPLURA

### Haematopinidae

Haematopinus asini (L.), the horse sucking louse

Derris, cube, or pyrethrum powders are reasonably effective.-- U. S. Bureau of Entomology and Plant Quarantine (627, p. 5).

Haematopinus eurysternus (Nitz.), the short-nosed cattle louse

There are four species of cattle lice in the United States. This species, also Linognathus vituli, and Solenopotes capillatus belong to Anoplura, and Bovicola bovis, to Mallophaga.

Demonstrations were conducted in Texas in 1938 to show that dipping in a mixture of 100 pounds of wettable sulfur, 10 pounds of cube (5 percent of rotenone), and 1,000 gallons of water would eliminate this pest. In 1939, 11,000 cattle were dipped, in 1940 more than 55,000, and by 1941 the practice had spread to 48 counties.--Texas A. and M. College (585).

Tests involving about 7,000 cattle showed that a sulfur-cube dip gave satisfactory control of this louse in 1940. The maximum duration of the egg stage was found to be much longer than the minimum duration of the nymphal stage, so that this louse cannot be eradicated by two treatments with the sulfur-cube dip no matter how they are spaced. In field tests in Texas all stages of this louse, except the eggs, were killed by dipping heavily infested cattle in the wettable sulfur-cube dip that had been used 21 days previously. This discovery that the tank need not be recharged for the second dipping will effect a considerable saving of labor as well as reduce by half the amount of insecticide formerly used.--U. S. Bureau of Entomology and Plant Quarantine (619, p. 93; 623, p. 95; 624, p. 48).

Spraying or dusting with sulfur-cube mixtures is recommended against cattle lice, including the short-nosed louse, but dipping is the better method. The following dip has so far proved efficient and safe as well as practical: No. 325 sieve wettable sulfur 100 pounds, cube or derris (5 percent of rotenone) 10 pounds, and water 1,000 gallons. If only a few animals are to be treated they may be sprayed or dusted with the sulfur-cube mixture.--Babcock and Cushing (27).



The War Production Board restricted the use of rotenone for most cattle lice, but it could be used to control the short-nosed cattle louse. An effective mixture was made by using 1 part of rotenone-dust containing 5 percent of rotenone to 5 parts of wettable sulfur, this dust to be applied thoroughly to all parts of the body, and repeated in from 2 to 3 weeks.--Maxwell (408).

Dusting is the common method of controlling lice on dairy cattle in the Northern States. A dust composed of 1 part of cube or derris (5 percent of rotenone) to 10 parts of wettable sulfur gives very good control of this louse. During the war rotenone substitutes were tried. The best one was composed of 1 part of sabadilla seed to 10 parts of wettable sulfur. Ground yam bean seed [This contains 0.1 percent of rotenone] with sulfur (1:10) was also very effective.--Matthysse and Schwardt (405).

Linognathus africanus K. and P.), a blue louse on goats

Five species of lice infest goats in the United States, viz., L. stenopsis (Burm.), L. africanus, Bovicola crassipes (Rud.) (penicillata Rud.), B. limbata (Ger.), and B. caprae (Gurlt). A mixture of wettable sulfur and cube or derris (4 to 5 percent of rotenone) is somewhat more efficient in killing lice than sulfur alone; 50 pounds of wettable sulfur plus 10 pounds of cube or derris powder per 1,000 gallons of water makes an efficient dip. The same combination in these proportions of sulfur and cube or derris is a good dust for hand treating infested goats; or sulfur, cube, or derris may be used alone.--Babcock and Cushing (28).

Linognathus pedalis (Osb.), a foot louse on sheep

Arsenical dips containing derris gave good results against this louse on sheep in New South Wales.--New South Wales Department of Agriculture (439).

Two treatments at intervals of 10 to 14 days with a recognized sheep dip containing derris or rotenone were recommended in Victoria. The sheep should stand in the bath for 5 minutes. Complete immersion is unnecessary unless there is evidence of the presence of lice on the head or body.--Shew (538).

Linognathus piliferus (Burm.), a sucking louse of dogs

Derris may be used as a dust (1 part to 2 parts of flour, corn-starch, or talcum).--U. S. Bureau of Entomology and Plant Quarantine (627, p. 22).

Linognathus setosus (Olfers), another sucking dog louse

This louse yielded most satisfactorily to a wash of derris powder that was compounded for treating warbles on cattle.--Spencer (556).

Linognathus stenopsis (Burm.), a blue louse on goats

Same as for L. africanus.--Babcock and Cushing (28).

Linognathus vituli (L.), the long-nosed cattle louse

In field tests in Texas one dipping in a solution containing cube and wettable sulfur killed all stages.--U. S. Bureau of Entomology and Plant Quarantine (624, p. 48).

For treatment, see Haematopinus eurysternus.--Babcock and Cushing (27); Matthyse and Schwardt (405).

Solenopotes capillatus End., little blue louse

See H. eurysternus, Babcock and Cushing (27); Matthyse and Schwardt (405).

#### Pediculidae

Pediculus humanus corporis Deg., the body louse

Derris powder, dusted and rubbed into the seams of all underwear and uniforms, was recommended in 1941 to control body lice among men recruited in Canada. It caused no irritation. Derris powder, either dry or as a saponified wash, was very effective.--Spencer (556, 557).

"The most potent threat to people in Great Britain will not be from the bomb and parachute but from the bug and parasite. The louse is the carrier of typhus, trench, and relapsing fever--three terrors which have destroyed whole armies. There is over-crowding underground and in the public shelters. The Ministry of Health may require large quantities of derris if louse infection breaks out in the air-raid shelters."--Great Britain Ministry of Health (244).

Pediculus humanus humanus L., the head louse

Derris powder, either dry or as a saponified wash, proved very effective in British Columbia.--Spencer (556).

Derris cream was prepared from a solution of derris extract in castor oil emulsified to make a cream containing 1 percent of rotenone and 7 percent of derris extract. The dosage ranged from 0.5 drachm for a child with short hair to 2 drachms for a woman with long, thick hair. This was enough to cover the whole scalp and saturate the hair. The head should be washed every day for 10 days after treatment. Successful results were obtained, live lice or eggs having been found after treatment sometimes in less than 2 percent of the cases and always in less than 9 percent, except in a group of evacuees from a Mediterranean country who refused to cooperate in hostels in London. No ill effects or discomfort were caused to large numbers of volunteers by the applications of this derris cream. This cream, lauryl thiocyanate, and Lethane 384 Special were found to have great advantages over all others.--Busvine and Buxton (96); Anonymous (6).

Lethane hair oil was recommended for the control of head lice as a result of laboratory and practical trials made by a technical committee at the instance of the Ministry of Health in London. From trials by the school medical services with this oil, or lauryl thiocyanate, and with derris cream Glover concluded that the Lethane hair oil was the best. In limited trials by the committee creams of derris or cube were efficient, and cases of reinfestation were rare, but application was slow. Rotenone powders were effective and would probably be of value for treating patients who are too ill to be disturbed.--Great Britain Ministry of Health (245).

In Ontario a preparation of Lethane 384 Special and extracts of pyrethrum and derris were tested. All these, at various concentrations in deodorized kerosene, and derris extract in olive oil, quickly killed head lice and their eggs on school children. The derris extract was effective at 0.5 percent of rotenone, and derris powder containing 5 percent of rotenone was also effective.--Twinn and MacNay (608); McLaine (386).

The application of derris powder to louse-infested heads is a practical method of controlling head lice, and if persistently and generally applied should result in the eradication of lice from a community. The usual delousing methods do not destroy or remove eggs, and they do not prevent subsequent infestations. Derris powder, on the other hand, although not destroying or removing the eggs, remains on the hair long enough, under the best conditions, to kill all young as they emerge and, while there, prevents infestation from other sources. In the clinic of the District of Columbia Health Department, 3,056 treatments were given to 804 patients, of whom 406 were pupils, 248 were home contacts, and 150 reopened cases. Absence from school on account of pediculosis can be reduced from weeks or months to a



few hours if pupils and home contacts are simultaneously treated and pupils can be allowed to attend school during the treatment period.--Trembley (595).

Phthirus pubis (L.), the crab louse

Derris powder, either dry or as a saponified wash, was very effective.--Spencer (556).

In Denmark a tincture of derris was applied as a spray and with brushes to 20 persons infested with crab or pubic lice. Baths of this tincture were very effective against the adults and their eggs.--Haxthausen (273).

All infestations of crab lice on soldiers were effectively treated in two military camps in Ontario, by one application of an ointment containing derris extract at concentrations from 0.5 to 2.5 percent of rotenone.--Twinn and MacNay (608); McLaine (386).

Derris is effective against this species, although the advisability of a general recommendation for its use is questionable because of the irritation produced in a considerable percentage of individuals, especially when the material is used too freely.--Trembley (595).

#### Unidentified Lice

Since nearly all lice on man and animals belong to Anoplura and Mallophaga, the unidentified lice and miscellaneous information will be discussed here.

In a review published in 1941 it was reported that derris and cube, diluted with inert dusts or powders, represent a common form of the newer flea and louse powders. There are also products on the market which are mixtures of rotenone dusts with pyrethrum. Although there has been a trend toward the wider use of rotenone in flea and louse powders in the United States in recent years, powdered derris root was used in these preparations in England over 20 years ago because its efficacy against these insects was recognized then. Most of the products are recommended also for control of lice, dog ticks, sticktites, etc., as well as fleas. Use on the human body to control chiggers, and head, body, and crab lice is also commonly suggested. The problem of controlling lice on canaries is rather unique. Powders made with rotenone and a talcum base give the canaries pneumonia, and the only product which can be used safely is straight pyrethrum powder.--Anonymous (5).



Infusions of Derris philippinensis were tested in the Philippine Islands against sucking lice on 2 cows and 11 water buffaloes, and against biting lice on a horse. Complete mortality of lice was obtained in every test with an infusion of fresh roots. Sucking lice removed from the host and immersed in an infusion for 20 seconds were apparently unaffected, and it was concluded that the lice were killed on the animal by ingesting some of the poison when they inserted the proboscis into the skin. Infusions of crushed dry roots of Derris sp. were very destructive to sucking lice on the cattle and buffaloes.--Gapuz (215).

On all the ranges in British Columbia where the derris treatment has been applied, cattle lice have ceased to give trouble.--Gunn (248).

In a review it is stated that derris is particularly suitable for control of fleas and certain forms of lice on animals and human beings.--Freak (199).

The rotenone treatment was preferred to the sodium fluoride treatment for the control of both sucking and biting lice of cattle.--Idaho Agricultural College (305).

In a preliminary note on a fish-poison plant (Calopogonium vellutium Benth), called catanga de macaco in Brazil, satisfactory results were obtained with the alcoholic extract against lice and ticks. By use of the Jones-Smith Durham color test, the extract appeared to contain rotenone.--Ildefonso Ramos (306).

Derris powder diluted with flour or talc (1:3) was recommended for control of cattle lice. A second treatment should be given in about 11 or 12 days.--Jones (325).

To combat ectoparasites in Brazil, use timbo powder or extract. To combat lice or fleas, put a little of the powder in the place most infested. The extract can be combined with fats, castor oil, vaseline, alcohol, or kerosene.--Meyer (416).

With wartime restrictions upon rotenone and pyrethrum, both used for lice control, a 1-percent nicotine dust with sulfur as a carrier was the most effective substitute available in 1943.--Munro and Telford (436).

A formula effective for lice on livestock, applied at 14- to 16-day intervals, contains 10 pounds of cube or derris (5 percent of rotenone), 100 pounds of wettable sulfur, and 1,000 gallons of water.--Thomssen and Doner (591).

In experimental work with small lots of cattle in various locations, some of the cattle in each lot were infested with one or more of the three species of lice commonly found on bovines. The animals were treated once with derris powder, and the lice were eradicated.--U. S. Bureau of Animal Industry (611).

## MALLOPHAGA

### Philopteridae

Columbicola columbae (L.), the slender pigeon louse

In Germany derris dusts gave good results against this species on pigeons.--Quittek (487).

### Trichodectidae

Bovicola bovis (L.), the cattle biting-louse

For treatment, see Haematopinus eurysternus.--Babcock and Cushing (27); Matthysse and Schwardt (405).

Bovicola caprae (Gurlt), the red goat louse

Bovicola limbatus (Gervais), another red louse on goats

Bovicola crassipes (Rud.) ( penicillata authors), a large yellow or hairy louse on goats

For treatment, see Linognathus africanus.--Babcock and Cushing (28).

Trichodectes canis Deg., a biting louse of dogs

This louse yielded most satisfactorily to a wash of derris powder that was compounded for treating warbles on cattle.--Spencer (556).

Derris dust and flour, cornstarch, or talcum (1:2) may be dusted into the hair of the infested dog.--U. S. Bureau of Entomology and Plant Quarantine (627, p. 22).

(Trichodeotes) Bovicola equi (L.), the horse biting louse

(Trichodectes) Bovicola pilosus (Gieb.), another biting-louse of horses

Derris, cube, or pyrethrum powders are reasonably effective against both biting and sucking lice on horses.--U. S. Bureau of Entomology and Plant Quarantine (627, p. 5).

(Trichodectes) Bovicola ovis (L.), a sheep biting louse

The rotenone-sulfur dip eradicated this louse on sheep.--  
Schwardt and Matthyse (530).

Unidentified chicken lice

Infusions of crushed fresh roots of Derris philippinensis in water (1:100 or stronger) were effective against all kinds of lice on fowls in the Philippine Islands. It was recommended that concentrations of at least 2 percent should be used. Concentrations as high as 5 percent caused no injury to the fowls.--Gapuz (213).

Proprietary powders containing sodium fluoride, sodium fluosilicate, pyrethrum, derris, or rotenone are satisfactory when dusted at the rate of about 1 pound per 100 hens.--Thomssen and Doner (591, p. 137).

Seventeen grown Buff Orpington hens, 3 large capons, and 11 baby chicks were thoroughly dipped on April 2 in a cube-sulfur dip, containing 1 pound of cube (5 percent of rotenone), 10 pounds of 325-mesh sulfur, and 100 gallons of water. Several examinations, made from the seventh day after dipping to April 30, did not reveal a single live louse. There was no injury. The fluff of the feathers, after drying, appeared better than ever and the chickens were fat and healthy.--  
U. S. Bureau of Entomology and Plant Quarantine (616).

SIPHONAPTERA

Hectopsyllidae

Echidnophaga gallinacea (Westw.), the sticktight flea

The use of derris or pyrethrum powder, applied as a dust or wash to infested dogs, was recommended in 1942.--Bishopp (54).

Pulioidae

Ctenocephalides canis (Curt.), the dog flea

Ctenocephalides felis (Bouche), the cat flea

Pulex irritans L., the human flea

These species and the preceding one are the four common fleas that infest dogs, homes, and farm buildings. Fleas on dogs and cats are easi-

ly destroyed by the application of a small amount of derris or cube powder scattered through the hair next to the skin along the neck and back of the animal. Washing the animal in water containing derris or cube powder and soap is an excellent method of control.--Bishopp (54).

In tests with six flea powders containing derris, pyrethrum, and sodium fluoride, the only one that gave satisfactory results consisted of 31.25 percent of derris and 68.75 percent of talc. Pyrethrum stupefies the fleas on cats and dogs temporarily while derris kills those with which it comes in contact. The combination of the two is useless because the pyrethrum causes the fleas to drop off the animal before the derris has time to act, and the fleas revive and return to the cat or dog after it has shaken off most of the powder.--Kissileff (341).

A wash of derris powder that was compounded for treating warbles on cattle was ineffective against cat and dog fleas.--Spencer (556).

In New South Wales to control fleas on cats and dogs it was recommended to dust derris or pyrethrum into the hair every week.--New South Wales Department of Agriculture (442).

#### Unidentified fleas

In West Australia pyrethrum or derris is most universally recommended against fleas in military camps.--Jenkins (321).

In Brazil a dip containing a dilute water extract of timbo roots and soap solution was found effective against fleas and lice on domestic animals.--Meyer (414).

To rid infested pets of fleas, dust them with derris or pyrethrum powder, or a combination of the two. If the treatment is to be a liquid shampoo, 2 ounces of derris powder added to a gallon of soapsuds is satisfactory.--Roselle and Haseman (515).

### THYSANOPTERA

#### Thripidae

#### Bregmatothrips iridis Watson, the iris thrips

For control two sprays are recommended: Derris powder and sulfonated castor oil in water, and nicotine sulfate (40 percent). These kill 99 to 100 percent of the thrips after several applications.--Utter and Smith (635).



One of the more important uses of rotenone is to control the iris thrips. The following spray mixture was found effective against thrips (except the gladiolus thrips) on certain flowering plants:

	<u>For small quantities</u>	<u>For large quantities</u>
Rotenone-containing root powder (4 percent of rotenone)	1 tablespoon-ful	1 pound
Alcoholic extract of pyrethrum (2 percent of pyrethrins)	4 teaspoon-fuls	2 quarts
Sulfonated castor oil	2 teaspoon-fuls	1 quart
Water	1 gallon	50 gallons

--Howard and coworkers (294, p. 31).

Diarthrothrips coffeae Will., a coffee thrips

In Tanganyika a spray of Derrisol in water or bordeaux mixture (1:500) was effective and was cheaper than nicotine sulfate.--Notley (447).

Frankliniella cephalica (Crawf.), a strawberry thrips

The control for this thrips (F. cephalica bispinosa Morgan) is a derris spray containing low concentrations (0.015:0.02 percent) of rotenone.--Smith (555).

Frankliniella fusca (Hinds), the tobacco thrips

Experiments with dusts and sprays of cube and pyrethrum were conducted on shade-grown tobacco in Connecticut. Pyrethrum dust was the only treatment that gave significant results. On the sun-grown tobacco, pyrethrum dust was also more effective than cube dust, and the latter was more effective when it contained no wetting agent. In later tests pyrethrum dust gave better control than did any of the other treatments, except that it was not significantly better than the treatment in which pyrethrum was alternated with cube. A cube-tobacco

dust was tested during four seasons, but it was found unsatisfactory against the tobacco thrips on shade-grown tobacco.--Morrill and Lacroix (427-429); Morrill (426).

Frankliniella vaccinii Morg., a blueberry thrips

Cube dust, derris dust, and nicotine-lime dust had no apparent effect.--Lathrop (358).

Frankliniella williamsi Hood

In the Philippine Islands this thrips can be controlled on maize by spraying with soap solution and nicotine sulfate or derris powder.--Otanés and Karganilla (453).

Heliothrips haemorrhoidalis (Bouché), the greenhouse thrips

Sprays containing rotenone were relatively ineffective.--Bartlett and Persing (36).

Derris was less effective than nicotine.--English and Turnipseed (168).

Isoneurothrips parvispinus Karny, a tobacco thrips

In Java a satisfactory spray was prepared by adding two parts by volume of neutral coconut oil or ground-nut oil to eight parts of a benzene extract of powdered derris containing 10 to 12 percent of rotenone. This was diluted for use and gave 98 to 100 percent mortality of the thrips on tobacco.--Thung (592, p. 43).

Rhopalothrips bicolor Hood, a prickly pear cactus thrips

A 5-percent rotenone powder, used at the rate of 2 pounds per 100 gallons of water with a spreader, gave a very good kill.--Bailey (29).

Taeniothrips simplex (Morison), the gladiolus thrips

Derris powder in combination with peanut oil and sodium oleyl sulfate gave poor control.--Johnson and Smith (328).

Sprays containing derris and peanut oil were ineffective and injured the plants.--U. S. Bureau of Entomology and Plant Quarantine (618, p. 64).

Thrips fuscipennis Haliday, a rose thrips

In tests against this thrips on roses in England, 3 days elapsed before derris powder caused appreciable mortality. A spray of 2 pounds of derris powder and 10 pounds of soft soap in 100 gallons of water on some occasions gave total mortality in 24 hours, but on other occasions it failed to do so in 4 days.--Speyer (558, p. 64).

Thrips lini Lad., a flax thrips in Holland

Experiments have shown that derris is valuable, but on biological grounds the value of insecticides against this thrips on flax in Holland is doubtful.--Doeksen (148).

Spraying with derris powder in water (rotenone: 1:5,000) proved very successful in field tests. Dusting and spraying with derris gave better results than with nicotine. Dusting gave better results than spraying.--Spoon (561, 562).

The best control of this thrips in Holland was obtained by dusting with derris powder (1 percent of rotenone) at the rate of 36 pounds per acre while the plants were wet with dew.--Wolters (700).

Thrips tabaci Lind., the onion thrips

Rotenone sprays or dusts did not give satisfactory control. Onion plants treated with an emulsified oil-rotenone extract were severely injured.--Anderson and Walker (17).

In field tests in 1940 a spray of nicotine sulfate and soap was superior to any other insecticide, having given 95 percent effective control. Sprays containing rotenone and oil, nicotine with oil, and derris alone or with talc or clay were superior to sprays of pyrethrum with oil or sulfur. Derris showed a marked residual effect, and its effectiveness was somewhat improved by the addition of talc or clay. In 1942 a rotenone extract with a resin residue spreader had a high immediate effect and good residual action. Derris powder (4 percent of rotenone) gave excellent kill within 24 hours, and reinfestation was slow. The residual effect of nicotine sulfate and soap was inferior to that of rotenone. In 1943 nicotine sulfate with soap was superior to all other treatments, having given 87 percent reduction of onion thrips. A commercial rotenone solution was nearly as effective and gave greater residual protection.--Bourne (69, p. 58; 70; 72, p. 35).

For control of the onion thrips in 1938 on carnations in greenhouses, derris or pyrethrum extract with spreaders, ground derris with karaya gum and a wetting agent, nicotine sulfate with molasses, and tartar emetic with spreaders were all more effective than tartar emetic or paris green with brown sugar. In 1940 rotenone and pyrethrum extracts combined with wetting and spreading agents failed to function as residual sprays against this thrips on carnations. The fact that they did not persist as toxic residues largely explained the failure.--Eichmann (161, 162).

## ORTHOPTERA

### Blattidae

Blattella germanica (L.), the German cockroach

Pure derris dust was apparently as effective as pure pyrethrum dust against the adults, but neither was as toxic as sodium fluoride.--Dewey (141).

Mixtures containing cube and derris powders were inferior to pyrethrum mixtures. Results with cube were variable and indicated a low toxicity. A derris mixture (1 percent of rotenone) gave 96 and 72 percent kill of males and females, respectively, while another mixture (0.5 percent of rotenone) gave 88 and 56 percent kills.--Gould (239, p. 92).

In a physiological study of the initial characteristic effects of insecticides upon the German cockroach, pyrethrum increased the rate of running while nicotine and rotenone (Derex) caused no acceleration.--Hutzel (304).

In runway tests the percentages dead after 7 days were 100 for sodium fluoride, 13 for pyrethrum, 83 for sodium fluosilicate, 67 for rotenone, and 83 for borax. The average numbers of hours in which death occurred were 32, 101, 71, 73, and 83, respectively. The percentages of cockroaches killed in 7 days after having been dusted were 100 for sodium fluoride, 89 for pyrethrum, 60 for sodium fluosilicate, and 70 for rotenone, and the hours to kill averaged 9, 29, 87, and 96, respectively.--Laudini and Sweetman (359).

Rotenone did not cause marked mortality of female cockroaches and did not cause them to drop their oothecae.--Parker and Campbell (455).

Periplaneta americana (L.), the American cockroach

In runway tests the percentages dead after 7 days were 79 for sodium fluoride, 45 for pyrethrum, 8 for sodium fluosilicate, 38 for



rotenone, and 29 for borax, and the hours to kill averaged 87, 34, 112, 37, and 127, respectively.--Laudini and Sweetman (359).

### Gryllidae

Acheta domestica (L.) (= Gryllus domesticus L.), the house cricket

When this pest invades houses it can be controlled by dusts of sodium fluoride, powdered borax, pyrethrum, or rotenone.--McDaniel (378).

Gryllotalpa sp., a mole cricket

In New South Wales a spray consisting of 1 ounce of derris powder, 3 ounces of soft soap, and 3 gallons of water, and a proprietary derris insecticide were both very effective.--New South Wales Department of Agriculture (444).

### Locustidae

Locusta migratoria manilensis Meyen, a subspecies of the common migratory locust

In laboratory and field tests fine derris dust (2 to 4 percent of rotenone) was deadly to the nymphs and adults. In the Philippine Islands derris powder may be employed instead of arsenicals, the extensive use of which is objected to because of the risk to stock and operators.--Otanés (452); Otanés and Karganilla (453).

In cage tests conducted in China with insecticides prepared from Celastrus angulatus and Millettia reticulata, the former was the more effective to the nymphs.--China Agricultural Research Bureau (112).

Locustana pardalina (Wlk.), the brown locust

A derris bait was ineffective in South Africa, and a suspension of 1 percent derris root (9 percent of rotenone) acted slowly, killing only 69.7 percent of them after 96 hours.--Nolte (446).

### HYMENOPTERA

#### Apidae

Apis mellifera L., the honeybee

A proprietary derris preparation, mixed with sucrose, was fed to bees in cages in England. It poisoned the bees only slightly for it

was somewhat repellent and therefore taken sparingly.--Butler and coworkers (97).

In cage tests to control insect vectors of azalea flowers, dusts of derris, pyrethrum, and nicotine sulfate apparently killed honeybees if dusted directly on them. Caged bees, fed on 5-percent molasses sprays containing derris powder to give a rotenone content of 0.0107 percent, were markedly affected.--Smith and Weiss (550).

Observations in potato fields located within easy bee flight of many commercial bee yards failed to reveal any honeybees frequenting the potato foliage, and no cases of bee poisoning were reported, although these fields were dusted several times with a cryolite-rotenone dust.--Webster (661).

Bombus impatiens Harr., a bumblebee

Caged bees, fed on 5-percent molasses sprays containing insecticides, were killed as follows: 73.5 percent by derris powder to give a rotenone content of 0.0107 percent, 68.2 percent by nicotine sulfate (2 quarts to 100 gallons), and 81.4 percent by tartar emetic (2 pounds to 100 gallons), while 11.5 percent died in the checks within 4 days. The molasses sprays poisoned with derris powder, nicotine sulfate, and tartar emetic markedly affected four other species of bumblebees, two species of carpenter bees (Xylocopa), and a solitary bee (Emphoropsis).--Smith and Weiss (550).

In tests against the preceding species of bees visiting azalea plants, derris powder dusted on them had no apparent effect. A bait containing derris powder was poisonous, but when it was sprayed on flowers in gardens, was ineffective.--Weiss and Smith (670).

#### Argidae

Arge rosae (L.)

In Schleswig-Holstein, arsenicals gave good control but dusts of derris or pyrethrum were preferable for vegetables or fodder plants. In field tests two proprietary dusts, combining derris and pyrethrum, gave 99.5 and 95.5 percent mortality of the larvae and were superior to two others containing pyrethrum alone.--Riggert (504).

In Switzerland derris dust was effective against the larvae on turnips.--Roos (514).

Formicidae

Camponotus herculeanus pennsylvanicus (Deg.), the black carpenter ant.

Four infested telephone poles were treated with derris powder (4.5 percent of rotenone) by blowing it into the top of the ant galleries with a dust gun, 24 grams per hole, and plugging the hole. In one pole, after treatment, a thriving colony was found, in two poles some ants were still alive, and in one pole all the ants were dead. The failure to eliminate the colonies in three of the poles was attributed to improper application of the dust, as the distribution in the galleries seemed to be poor.--Friend (201).

Formica exsectoides Forel, the Allegheny mound ant

Encircling a large mound with a band, 1 foot wide, of pure ground derris root (4 percent of rotenone) practically exterminated the colony of ants.--Johnson and Friend (332).

Tenthredinidae

(Caliroa) Endelomyia aethiops (F.), the rose slug

One of the more important uses of rotenone powder is to control rose slugs.--Howard and coworkers (294, p. 31).

Dust the slugs on rose bushes with copper-rotenone dust.--McDaniel (379).

Caliroa cerasi (L.), the cherry or pear slug

Airplanes were used successfully in dusting cherry and pear orchards with derris compounds to control the pear slug.--Lockwood (370).

Hoplocampa flava (L.), the plum fruit sawfly

When this insect is a pest in England, a spray of 2 pounds of derris powder and 1 gallon of white oil per 100 gallons should be applied when the "cots" are splitting.--Hey (285).

A spray containing 0.67 percent of grade G oil and sufficient material to give 0.004 percent of crystalline rotenone should be used against the plum sawfly in England.--Kearns and Martin (339).

Hoplocampa minuta (Christ) (= H. fulvicornis (Panz.)), the continental plum sawfly

A 3-percent quassia solution gave far better results in eradicating

this pest in Denmark than spraying with a derris suspension.--Bovien and Stapel (78).

Derris sprays were effective.--Anonymous (1).

Hoplocampa testudinea (Klug.), the European apple fruit sawfly

In England if lead arsenate or derris is included in the spray to control this pest it must be applied not later than 8 days after four-fifths of the petals have fallen. On varieties susceptible to sulfur injury, a carefully timed spray of derris extract in white oil should be applied at petal-fall. Trees on which appreciable numbers of red mites are present 10 days later should receive a fourth spray of lime-sulfur and a wetter, 1 percent of white oil or, preferably, derris in white oil.--Hey (285).

Laboratory tests with derris (4 percent of rotenone), at 4 pounds per 100 gallons of water, against the young larvae were very promising as most of the larvae died on coming in contact with the sprayed apples without attempting to enter the fruit.--Pyenson (480).

(Monophadnoides) Blennocampa rubi (Harr.), a raspberry sawfly

If infestations of the larvae appear early in the season on leaves of strawberry, a spray of 3 pounds of lead arsenate in 100 gallons of water should be applied. Pyrethrum or derris sprays should be applied against those that develop after the fruit is set.--Slate and coworkers (544, p. 51).

Nematus sp.

Since neither pyrethrum nor derris scorches the shoots of conifers in May in Germany, these can be used to control sawflies.--Gäbler (208).

Priophorus rubivorus Rohw., a raspberry sawfly

Three applications of derris, cube, or timbo root, either as dust or spray, are recommended.--Hanson and Webster (260, p. 10).

Pristiphora abietinus (Christ), the lesser spruce sawfly

In Germany a proprietary dust of pyrethrum and derris gave good results in the laboratory, but it was unsatisfactory in the field owing



to unfavorable weather.--Gäbler (209).

Pristiphora erichsonii (Htg.), a larch sawfly

A dust containing 0.075 percent of rotenone acted slowly but killed a number of the larvae.--McDaniel (377).

Profenusa canadensis (Marl.) ( P. collaris McG.), a sawfly-cherry leafminer

A spray containing 1 pint of aliphatic thiocyanate (24 percent) in an oil base, 4 quarts of summer oil, 2 ounces of blood albumin, and 4 pounds of cube root (5 percent of rotenone) per 100 gallons, applied on May 16, gave 84 percent kill of the young larvae in their mines. Sprays containing pyrethrum extract, alone or with rotenon were ineffective, and nicotine sulfate and oil, or aliphatic thiocyanate and oil with cube gave very poor results.--Hamilton (255).

(Pteronidea) Nematus ribesii (Scop.), the imported currantworm

Sprays of derris gave better results than those of lead arsenate in laboratory and field tests in Holland.--Houten (292).

One of the more important uses of rotenone is to control the currantworm.--Howard and coworkers (294, p. 31).

Rotenone is effective; nicotine is ineffective.--McIndoo (383).

#### Diprionidae

Diprion pini (L.), a pine wasp, or pine sawfly

In control work on this insect in Holland, a dust consisting of an inert carrier, derris, and pyrethrum was used against the larvae.--Fransen (197).

Diprion simile (Htg.), the introduced pine sawfly

Neodiprion lecontei (Fitch), the red-headed pine sawfly

Neodiprion pinetum (Nort.), the white-pine sawfly

Lead arsenate and cryolite were the best controls. A dust containing 0.75 percent of rotenone acted slowly, but killed a number of the larvae and would probably be useful where infestation occurs on conifers near vegetables.--McDaniel (377).

COLLEMBOLA

Entomobryidae

Seira platoni (Nicolet) (= Sira nigromaculata Lubbock), a springtail

Springtails were found breeding in the cork insulation around the brine pipes extending from a central refrigerating plant to individual refrigerators in a 132-tenant apartment. The insects entered the refrigerators where they were seen on various foodstuffs. A 5-percent solution of rotenone in methyl formate was injected into the cork every 6 feet in the risers of the refrigerating pipes. Not a single tenant complained of the odor from the formate and not a single springtail was reported in the apartment during 8 years after the treatment.--Sanders (519).

DERMAPTERA

Forficulidae

Forficula auricularia L., the European earwig

Of the 54 poisons tested in baits, rotenone was twentieth in the list in descending order of effectiveness.--Crumb and coworkers (130, p. 55).

Sprays and dusts containing lead arsenate or derris were not satisfactory for this pest on hops in England.--Masse (402).

TRICHOPTERA

Limnephilus lunatus Curt., a caddis fly

Larvae on watercress in England were killed by derris (0.001 percent of rotenone in the water). This treatment proved satisfactory, and later reports confirmed that the beds were free of pests.--Walton (652).

THYSANURA

Lepismatidae

Thermobia domestica (Pack.), the firebrat

Baits containing derris (1 and 4 percent of rotenone) killed firebrats within 24 hours, probably by contact, for no feeding was observed.

At 0.5 percent rotenone content, mortality from the derris bait was still considerable, yet no feeding was indicated.--Richardson and Seiferle (502).

## ACARINA

### Acaridae

(Tyroglyphus) Tyrophagus putrescentiae (Schr.)=(T. longior Gerv.)

In tests on control of this mite in mushroom beds in England dusts containing pyrethrum, derris, and nicotine were ineffective.--Read (494).

### Argasidae

(Ornithodoros) Otobius megnini (Duges), the spinose ear tick

Derris or cube powder (5 percent of rotenone) mixed with medicinal mineral oil (1:10 parts of the oil) and dropped into the ears of dogs will kill these ticks.--Bishopp and Smith (57).

Ornithodoros moubata (Murray), the African relapsing fever tick

Medium petroleum oil was superior to peanut oil as a carrier of rotenone in xylenol tested against this tick. The solutions of rotenone in xylenol and oil showed no deterioration after storage in the darkness at room temperature for 6 weeks. These solutions proved far less toxic than an equal weight of pyrethrin I in medium petroleum oil.--Robinson (509).

### Demodicidae

Demodex canis Leydig, the dog follicle mite

In Brazil severe mange, such as caused on dogs by this mite, is best treated by the following lotion: 2 parts of timbo root powder are mixed with 10 parts of benzene or carbon tetrachloride, and kept for 2 days in a tightly corked bottle. The mixture is then incorporated with 100 to 200 parts of diesel oil, cottonseed oil, or even kerosene.--Meyer (414).

The most promising remedy for demodectic or red mange appears to be a 1-percent solution of rotenone in alcohol or oil. The derris wash recommended for sarcoptic mange has effected cures in a number of instances.--Price and Bishopp (475); U. S. Bureau of Entomology and Plant Quarantine (627, p. 20).

Eriophyidae

(Epitrimerus) Abacarus hystrix (Nal.), the grain rust mite

Rotenone dust was not effective against this mite on timothy.  
--Pepper (459).

Epitrimerus vitis (Nal.), a gall mite

Three percent of Selinon was more effective against this mite on grape vines in Germany than light oil in combination respectively with nicotine, pyrethrum, or derris.--Jancke (315).

(Eriophyes) Cecidophyes ribis (Nal.), the currant bud mite

A post-blossom spray of derris and soap did not injure the black currant in England and was less effective against this mite than a preblossom application of 2 percent of lime sulfur.--Montgomery and coworkers (421).

(Eriophyes) Aceria sheldoni (Ewing), the citrus bud mite

The most effective combinations of powdered rotenone-bearing roots with light-medium oil ( $3/4$  to 1 percent) were two-thirds as effective as the same oil (1- $2/3$  percent) used alone.--Boyce and coworkers (81, 82).

Ixodidae

Amblyomma maculatum Koch, the Gulf Coast tick

Studies of this tick were made to find a substitute for rotenone.  
--U. S. Bureau of Entomology and Plant Quarantine (628, p. 144).

Dermacentor albipictus (Pack.), the winter tick

Mopping the infested horses with a mixture of 2 ounces of finely ground derris (5 percent of rotenone), 2 ounces of neutral soap, and 1 gallon of water will probably kill all the ticks with which the wash is brought in contact.--Bishopp (52).

The standardized derris powder method was effective in controlling the winter tick.--Gunn (247, 248).

Dermacentor andersoni Stiles, the Rocky Mountain spotted fever tick, a wood tick

For treatment use the derris dip recommended for the American dog tick (D. variabilis).--Bishopp and Smith (57).



Treatment with derris dust gave promising results against this tick on sheep and cattle, although its complicated life history renders control more difficult. The warble-fly wash, which contains standardized derris, was applied over the shoulders and around the backs of the heads of cattle, and in every instance the animals remained free of ticks. Good results with this method were reported by stockmen, but the dry derris powder method would be safer, particularly in cold weather.--Gunn (247, 248).

Arsenical dips are still the best means of ridding stock of ticks, particularly D. andersoni, but their effectiveness in giving protection from reinfestation remains in doubt. Derris and pyrethrum are highly lethal to ticks and relatively nontoxic to mammals, but their cost is high and their lasting quality poor. It was found that ticks would readily infest lambs treated heavily with derris powder, and although many were killed, a few succeeded in attacking and engorging.--Mail (388).

Dermacentor nigrolineatus (Pack.), the brown winter tick

A wash of 7 ounces of derris (5 percent of rotenone), 1.5 ounces of neutral soap, and water to make 1 gallon was very effective, killing even the most resistant adults and protecting the animals from reinfestation to a considerable degree.--Bishopp (52); U. S. Bureau of Entomology and Plant Quarantine (624, p. 48).

Dermacentor sp.

In the Philippine Islands a dust containing 1 to 2 percent of rotenone with cassava starch killed ticks on dogs in 24 to 72 hours.--De Jesus and Gapuz (324).

Dermacentor variabilis (Say), the American dog tick, the common wood tick

The most effective way to prevent injury to dogs by ticks is to wash or immerse the dogs twice a week in derris dip, which is prepared by dissolving an ounce of mild soap in a gallon of warm water and stirring 2 ounces of fine derris or cube (3 percent of rotenone) into the solution. If a dip cannot be used conveniently, derris or cube powder may be applied as a dust, care being taken that it penetrates the hair and reaches the skin.--Bishopp and Smith (57); Harwood (268).

If dogs that have access to the house are not kept free of ticks by dusting with a mixture of derris root and talc (3:1) or by some other means, elimination of the young ticks may be extremely difficult.--Headlee (274).

Systematic dipping in derris of all dogs in one area twice each week for four seasons, combined with control of meadow mice for one season, was followed by almost complete absence of the American dog tick.--U. S. Bureau of Entomology and Plant Quarantine (624, p. 47).

Haemaphysalis leporis-palustris Pack., the rabbit tick

If dogs become infested with this species, treat them with derris-talc mixture.--Headlee (274).

Ixodes holocyclus Newm., the bottle tick, scrub tick

In Queensland it was recommended that foals and calves should be sprayed every 7 days during the tick season with the wash of derris and soap used for dogs. Dust dogs with derris powder, or wash them in an infusion of derris in water. The infusion is made by soaking 1.5 to 2 ounces of derris powder in 1 gallon of water overnight or for about 12 hours, using sufficient soap to produce a good lather.--Roberts (508).

Ixodes ricinus (L.), the castor-bean tick, sheep tick

In England much loss can be prevented by dipping the entire flock 4 to 8 days prior to lambing (this treatment will give comparative freedom from ticks for 3 weeks), and by the application of derris dust to newlyborn lambs at 2 to 3 weeks intervals, until the end of the spring season of tick activity.--Stewart and Ponsford (571); Stewart (570).

Rhipicephalus sanguineus (Latr.), the brown dog tick

Probably the best method of killing ticks on dogs is to apply a wash of 2 ounces of derris or cube powder (3 percent of rotenone), 1 ounce of neutral soap or soap flakes, and 1 gallon of tepid water. Ticks may also be killed by dusting with derris or cube powder (3 to 5 percent of rotenone) or with fresh pyrethrum. During the war the use of rotenone on dogs was not permitted, but an 0.18-percent arsenic trioxide dip could be used in place of derris or pyrethrum dust for infested dogs.--Bishopp (55); Bishopp and Smith (57).

Same treatment as for Dermacentor sp.--De Jesus and Gapuz (324); fer D. variabilis.--Harwood (268).

Dogs that are infested should be dusted with the derris-talc mixture. Thorough spraying of the infested places with oil containing pyrethrins or rotenoids should result in killing all ticks with which the spray comes in contact.--Headlee (274).

To help eradicate ticks from a veterinary hospital, a mixture of derris and pyrethrum powder in equal parts was sprinkled in the cracks and crevices, and the dogs in the ward were dusted daily with derris powder (4 percent of rotenone). The derris caused the ticks to release their hold on the host in addition to killing them. The ward was thus freed of ticks.--Koutz (345).

Extracts of timbo roots were very toxic to ticks in Brazil, and a treatment for infested dogs gave 99.4 percent mortality in 24 hours.--Meyer (415).

In Queensland arsenical and phenolic dips kill ticks on dogs but do not prevent larvae, nymphs, and young adults in the dogs' sleeping quarters from attaching themselves shortly after treatment. The use of derris was found to be the only way of preventing immediate reinfestation.--Roberts (507).

#### Penthaleidae

Halotydeus destructor (Tucker), the red-legged earth mite

Penthaleus major (Dug.), pea mite or another red-legged earth mite

Derris or pyrethrum dusts are recommended for these mites on garden plants in Tasmania.--Evans (171).

Recommendations for control in Victoria include dusting young plants with a mixture of derris powder and 2-percent nicotine dust (1:8). Applications should be made every 3 or 4 days as long as the mites are present.--Pescott (464).

In New South Wales excellent control of Penthaleus major on beets was obtained with a spray of nicotine sulfate in white oil emulsion, and with a mixture of 1 pound of powdered derris and 8 pounds of a proprietary nicotine dust. Adequate control was obtained with a spray containing 4 fluid ounces of a 10-percent rotenone solution in benzyl alcohol, and 6 fluid ounces of emulsified white oil, in 5 gallons of water.--Wallace (651).

In Japan all the mites (P. major) on wheat were killed by sprays of soap solution containing pyrethrum, derris, nicotine sulfate, or fish oil.--Tamura (580).

#### Psoroptidae

Otodectes cynotis (Hering), the ear mange mite

An ointment consisting of 1 part of derris powder (5 percent of rotenone) in 10 parts of petrolatum or olive oil has been found effective against this mite on dogs.--Price and Bishopp (475).



Psoroptes spp.

Infusions of crushed fresh or dried derris roots were effective against psoroptic scabies on horses and carabaos in the Philippine Islands. Dried root infusion cured carabao scabies when applied twice.--Gapuz (214).

Sarcoptidae

Sarcoptes scabiei (Deg.), the human itch mite

In England the time taken to cure 20 cases (as a group) of scabies by each of five different treatments was as follows: Sulfur ointment, 46 days; sulfur ointment and confection of sulfur, 59 days; benzyl benzoate, 30 days; rotenone, 38 days; and derris root, 41 days. The derris root method is the most satisfactory. It is very cheap, clean and effective. Benzyl benzoate is the quickest, but may occasionally cause dermatitis. Rotenone is very expensive and caused dermatitis in 3 of the 20 cases. Sulfur ointment is cheap and efficient but is a very messy, annoying method.--Buchan (95).

Rotenone has been used successfully in an ointment for the treatment of scabies.--Lunn and coworkers (151).

The substances in popular use for the control of scabies contain sulfur, rotenone, or benzyl benzoate. In a study in which rodents were used, rotenone was discarded at an early stage because of the severe scrotal dermatitis that is occasionally provoked.--Gordon and Seaton (237).

Experiments with scabies on infested soldiers in two Canadian military camps showed that aliphatic thiocyanates, derris, cube, or pyrethrum extracts incorporated with carrier materials in the form of lotions and ointments, were very effective.--McLaine (386, p. 11).

One application of a 2-percent emulsion of rotenone, called "Sarevan," was much less effective than sulfur ointment for scabies. A number of patients were treated with four applications of it, and a satisfactory cure was obtained but some of them developed an intractable scrotal dermatitis.--Mellanby and coworkers (411).

In England in 1941 applications of a derris lotion were made morning, noon, and night for 2 days; 52 patients who wore only pyjamas, and 38 others who wore their usual clothing, were all cured of scabies; 35 of the men treated complained of a burning sensation in the scrotum and penis. The treatment was recommended for civilians in shelters and



in the army. In 1942 nearly 500 cases of scabies were treated with the derris lotion consisting of 4 ounces of derris powder, 1 gallon of water, and 16 teaspoonfuls of soap flakes. Six applications to the body three times a day for 2 consecutive days cured practically every case. It was the most effective method.--Saunders (520, 521).

For the treatment of scabies in clinics and hospitals of Great Britain the following rotenone formulas were used in 1942:

- |     |  |              |
|-----|--|--------------|
| (1) | Derris root powder -----               | 1/2 oz.      |
|     | Soap flakes -----                      | 2 drs.       |
|     | Water, q.s. to make -----              | 1 pt.        |
| (2) | Derris root powder -----               | 1/2 to 1 oz. |
|     | Sulfonated Lorol T. A. -----           | 1 fl. oz.    |
|     | Water, q. s. to make -----             | 1 pt.        |
| (3) | Rotenone -----                         | 2.0 parts    |
|     | Chloroform -----                       | 6.0 parts    |
|     | Lanette wax S. X. -----                | 1.25 parts   |
|     | Water, to make -----                   | 100.0 parts  |
| (4) | Rotenone -----                         | 2 parts      |
|     | Solvent -----                          | q.s.         |
|     | Cellofas medium viscosity W.L.D. ----- | 0.5 parts    |
|     | Sodium lauryl sulfate -----            | 2.5 parts    |
|     | Water, q.s. to make -----              | 100.0 parts  |

--Skinner (543).

All but 3 of 50 cases of scabies were cured by one application daily of a lotion containing 4 ounces of derris powder to 1 gallon of water and 18 drachms of soft soap. No dermatitis or other unfavorable sequelae were reported.--Stuart (575).

Rotenone in the form of 1 or 2 percent lotions, with a base similar to that of many hand lotions (quince seed, Irish moss), produced prompt cure of scabies in 24 unselected cases encountered in clinic and institutional practice.--Thomas and Miller (590).

Ninety percent of the cases of scabies on soldiers were effectively treated by one application of an ointment containing 10 to 50 percent of Lethane or pyrethrum, or derris extract at concentrations ranging from 0.6 to 1.8 percent of pyrethrins, and 0.5 to 2.5 percent of rotenone. The remaining cases were cured by a second application.--Twinn and MacNay (608).

Sarcoptes scabiei canis Gerl., mange or sarcoptic mite of dogs

Derris ointment similar to that recommended for the treatment of ear mange, and a wash consisting of 4 ounces of derris powder (5 percent of rotenone), 1 ounce of neutral soap, and 1 gallon of warm water have been found highly effective in curing sarcoptic mange. This mixture should be rubbed in well with a brush, two or three treatments being necessary to cure a dog.--Price and Bishopp (475); U. S. Bureau of Entomology and Plant Quarantine (627, p. 17).

Sarcoptes spp.

Dipping of foxes, on fox farms in Germany, was not completely effective. Infested foxes, immersed in a 2-percent derris dip, died of poisoning, even though washed with water afterwards.--Schoop (524).

Sarcoptes suis Gerl.

An emulsion of neats-foot oil containing 1 percent of derris powder effected considerable improvement in 20 pigs, but not a complete cure of the mange.--Pullar (477).

#### Tarsonemidae

Tarsonemus pallidus Banks, the cyclamen mite

A spray mixture consisting of derris powder, pyrethrum extract, and sulfonated castor oil with water was effective against this mite on chrysanthemums.--Howard and coworkers (294, p. 31).

#### Tetranychidae

Paratetranychus citri (McG.), the citrus red mite

Low dosage oil sprays (0.75 percent of light-medium oil) in combination with powdered rotenone-bearing roots were fairly effective.--Boyce and Korsmeier (81).

A spray consisting of light-medium oil (0.5 to 0.75 percent) with rotenone may be used for control.--Quayle (482, p. 26).

Paratetranychus pilosus (C. & F.), the European red mite

A spray containing rotenone (1 percent in mannitan monolaurate, 1 pint per 100 gallons) killed a majority of the mites within 3 days, and later was considered effective, but did not eradicate the pest.--Baten and Hutson (38).

Five tests of spray materials containing rotenone gave a control of 88.5 percent, while pyrethrum spray containing an excellent spreading agent gave a 97 percent control.--Bourne and Whitcomb (75).

If an infestation develops during the summer, fair control may be obtained by thorough spraying with 0.5-percent summer oil plus 2.5 pounds of derris powder (5 percent of rotenone) per 100 gallons, or other rotenone compounds at the directions of the manufacturers.--Cutright (133).

Attempts to control the European red mite on apple with sprays at the pink bud stage failed. The most effective were summer oil emulsions, and a spray of 4 pounds of derris powder (5 percent of rotenone) per 100 gallons of water with a spreader. Rotenone did not affect the eggs, so two applications of derris 10 days apart were required for control equivalent to that given by one application of summer oil. Rotenone was inferior to the ground root.--Dean (136).

Field tests were conducted with Syntone, a whitish emulsion containing 2.8 percent of rotenone, an oil, and a spreader. No deterioration occurred in the commercial concentrate. A spray containing 1.5 pints of Syntone, 1.5 pints of Q oil, and water to make 100 gallons killed 99 percent of these mites.--Garman and Townsend (225, 226).

In England a block of apples was sprayed with lime sulfur at petal-fall. Adjoining trees were similarly sprayed with lime sulfur, and then given an application of derris in white oil. Observations showed a severe attack on the first block but only a few mites on the second.--Hey (286).

The best treatment against the European red mite on apple and plum in Ohio is to apply a dormant oil if the overwintering eggs are numerous, and a rotenone spray (Botano R) in summer if the oil has been omitted and if the mites increase to dangerous numbers by mid-summer.--Houser and Cutright (291).

In its active stages this mite in England is readily killed by lime sulfur, rotenone materials, and petroleum-oil contact sprays. The summer eggs and molting nymphs are not killed by lime sulfur and rotenone materials.--Kearns and Martin (339).

Some promise was shown by rotenone against the European red mite.--Parrott (457).

When cube powder was combined with 1 pint of mannitan monolaurate, fair control was obtained.--Steiner (565).

Satisfactory control resulted when cube was used in oil in delayed dormant spray.--Steiner and Worthley (567).

Tetranychus pacificus McG., the Pacific mite

The most effective summer spray in 1939 was Selocide. Rotenone compounds and various combinations of sulfur were somewhat less effective, but gave satisfactory control when applied before infestation became severe. Of sprays applied in the summer of 1940, those containing rotenone materials were effective against the mites but not against the eggs.--Webster and Moore (665); Webster and coworkers (667).

Tetranychus spp., the common red spiders

The dust, made of Cuproside (G. A.) 6 percent, dusting sulfur 30 percent, derris (5 percent of rotenone) 15 percent, and pyrophyllite 49 percent, was effective in control of downy mildew, and red spider.--Cunningham (131).

A spray consisting of derris powder, pyrethrum extract, and sulfonated castor oil with water was effective against red spiders.--Howard and coworkers (294, p. 31).

To control the Mexican bean beetle and red spiders, if the latter are present, the following was recommended: 4 pounds of derris, cube, or timbo (5 percent of rotenone) in 100 gallons of spray, or 40 pounds of dust, with the addition of sulfur, or a copper compound if fungus diseases are to be controlled. Sprays containing 12 pounds of wettable sulfur per 100 gallons alone or with 4 pounds of cube powder, and dusts of 50 percent of sulfur, alone or with 10 percent of cube, applied four times at intervals of 10 to 12 days, were extremely effective.--Huckett (299, 300).

Rotenone is relatively more effective than nicotine against the common red spider.--Isely (311, p. 25).

To control the red spider on roses apply copper-rotenone dust.--McDaniel (379).

RS-380, a vegetable and petroleum oil solution of rotenone and other derris extractives, tested against the red spider, gave effective control of the mites and their eggs within 4 days.--Parker (456).

Control measures for this pest comprise two or more applications of a sulfur dust, or of sprays containing wettable sulfur, derris, or



nicotine. A spray of derris powder (4 percent of rotenone) and 1 pint of sulfonated castor oil in 50 gallons of water, is very effective.--Weiss and Baumhofer (669).

The toxicity of rotenone sprays to red spiders on carnations increased with increased temperature. Effectiveness of suspensions of derris, cube, or pyrethrum powder in water was less than their extracts. Under normal greenhouse conditions, derris or cube powder (4 percent of rotenone), mixed with sulfonated castor oil (1:300) and diluted at the rate of 2 and 3 pounds per 100 gallons, gave only moderate control of red spiders on roses after three applications, but good control after four applications.--Whitcomb (675, 676).

In tests with eight commercial rotenone preparations against the red spider on roses in greenhouses, the addition of a neutral copper fungicide decreased the efficiency of rotenone sprays. Satisfactory control was obtained, after four applications at weekly intervals, only with those materials which contained some insecticidal ingredient in addition to rotenone, and an emulsifier. The most effective material was technical mannitan monolaurate to which 1 percent of rotenone and 2.6 percent of other derris extractives was added. When diluted (1:400) this was the only spray material which consistently killed 90 percent or more of red spiders without injury to the plants. Several of the rotenone sprays, which gave unsatisfactory control of the red spider on roses, gave excellent control of it on potted carnations. A commercial spray containing mannitan laurate and rotenone (1:400) killed 89 percent of red spiders in four applications; at 1:600 strength, 73 percent. Two other rotenone materials gave fair control of this pest on greenhouse plants.--Whitcomb and coworkers (682, p. 39, 62-3, 67).

Tetranychus telarius (L.), the red spider in Europe

In England infested tomato plants should be sprayed with derris extract until the end of May.--Bewley (49).

Established infestations of this pest on plants in greenhouses in England are very difficult to eradicate, but a simple means of preventing its establishment has been evolved. Derris powder and soft soap are added to the water used for the routine "damping-down" of the plants, at the rate of 1.5 and 2 pounds respectively, per 100 gallons. The plants are thoroughly sprayed each morning, noon, and night, and consequently a thin deposit of derris accumulates on the leaves.--Massee (401).

Trombiculidae

Eutrombicula alfreddugesi (Oud.), the common chigger

Treating the feet, ankles, calves or shoes, stockings and trouser legs with a few pinches of sulfur, pyrethrum, or derris powder will give protection against this most troublesome pest of man.--Stone and Haseman (574).

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